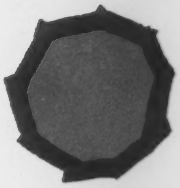
Materials in Design Engineering



NEW WAYS TO STRENGTHEN METALS

page 115

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ANACONDA EXTRUDED SHAPES

when you want extra strength . . . when you need longer wear!

When you are called upon to incorporate performance characteristics such as these, to a greater degree than is provided in parts made from sand castings, consider Anaconda Extruded Shapes. Parts cut from extruded shapes *are* superior in quality and *do* improve the strength and durability of your finished product.

Anaconda can provide long lengths of preformed shapes exactly suited to your design requirements. Parts made from these extruded brass shapes are characterized by their strong, homogeneous, wrought-metal structure. What's more, the smooth, extruded surfaces also reduce many finishing operations—additional savings for you.

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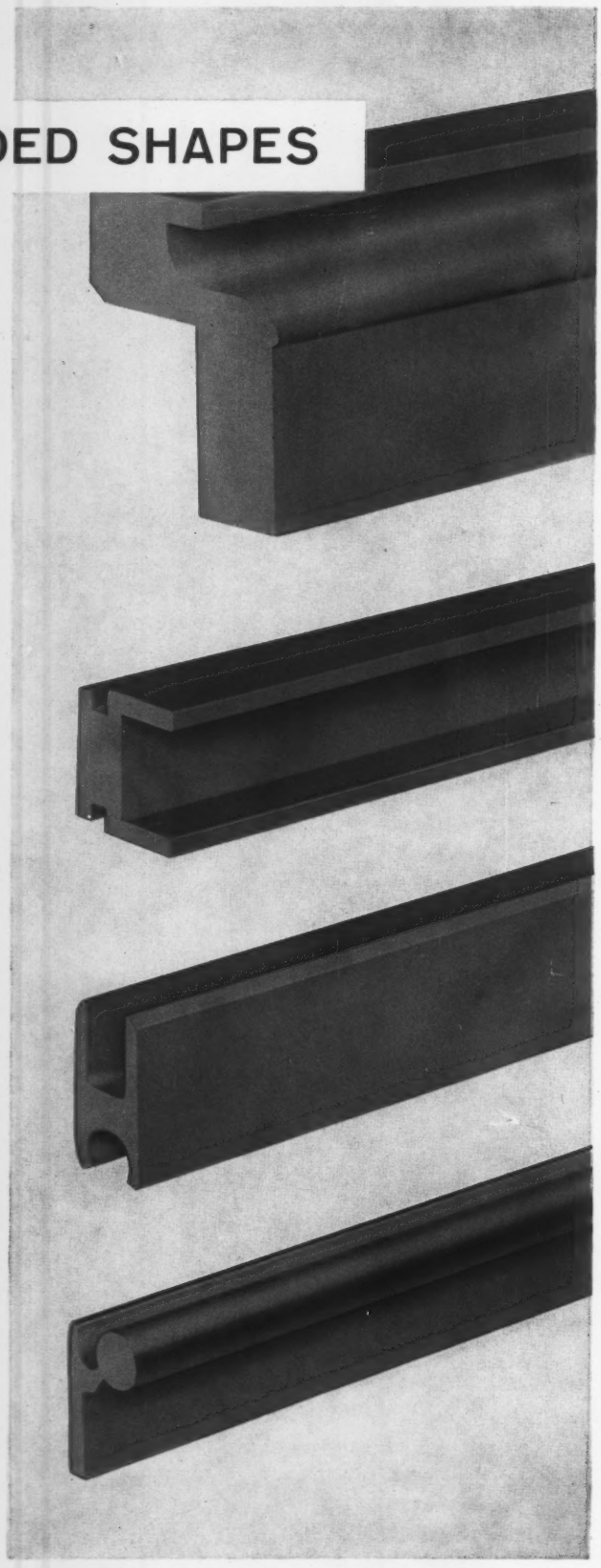

EXTRUDED SHAPES

ANACONDA®

AMERICAN BRASS COMPANY

For more information, turn to Reader Service card, circle No. 334

OCTOBER, 1961 | VOL. 54, NO. 4

Materials in Design Engineering®

FORMERLY MATERIALS & METHODS

APPLICATION OF METALS, NONMETALLICS, FORMS, FINISHES

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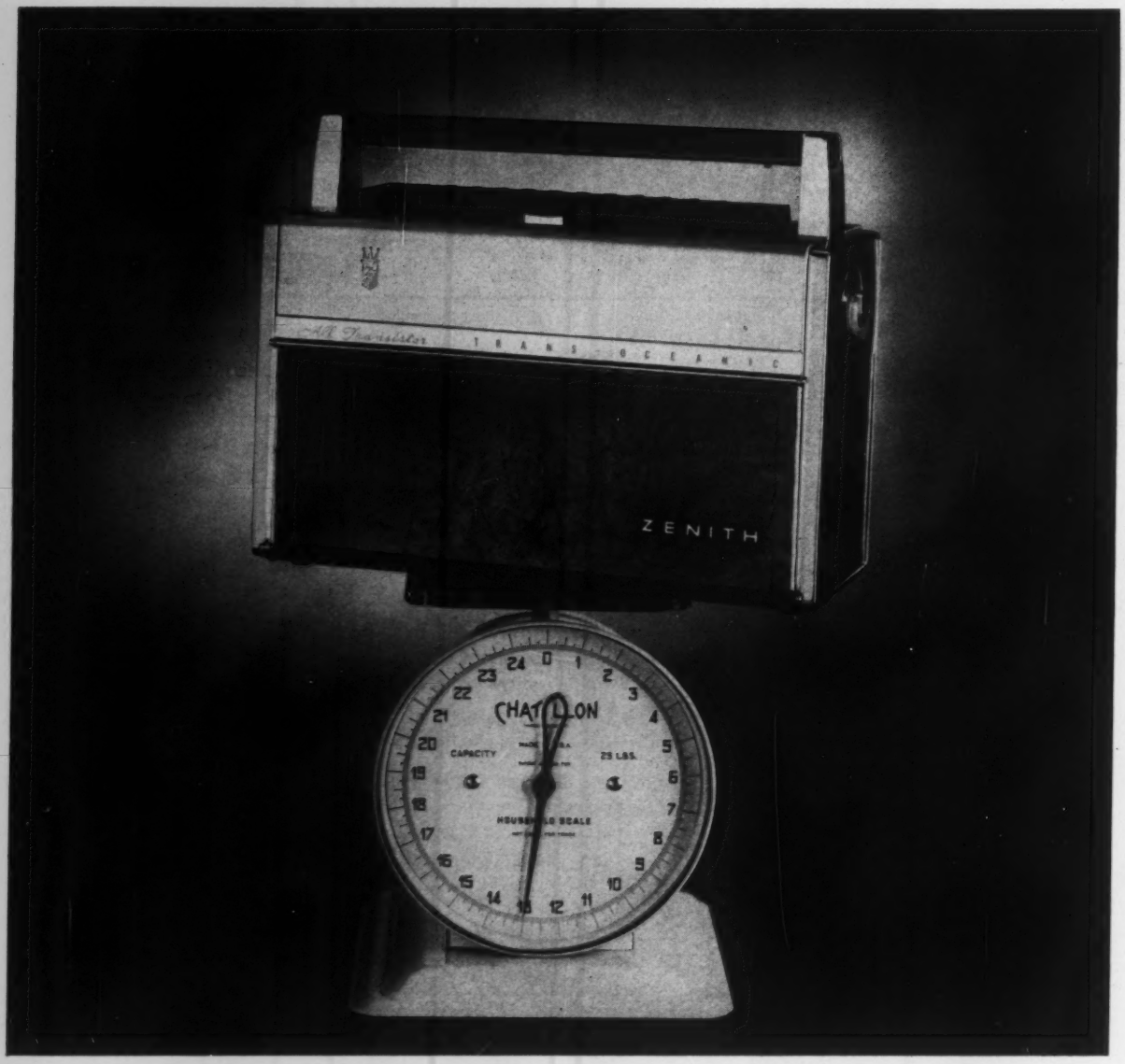

ASSIGNMENT: A weighty one. Take the Zenith Royal 1000 Transoceanic portable radio and pare off half of its 26 pounds—without reducing performance. How do you do it? With an aluminum case? No. With plastics? No. You do it with a housing made from eleven thin-wall, high strength zinc die castings. You do it with the only material and method that can provide the "as cast" tolerances necessary for the flush-fit the design demands. You rely on a material that can be cast thinner, and yet stronger, than any die casting competitor; a material whose castability permits shapes and intricate sections prohibitively expensive by other fabricating techniques. You know that assembly will be easy, because you can use self-tapping screws, and speed nuts on the cast bosses. You know that finishing will be a pleasure, with a smooth surface that readily accepts bright, satin and brush-finish chrome plate, as well as paint to fill the cast lettering. We could go on and on, detailing the advantages each one of the eleven zinc die castings demonstrates, pointing out the skillful designing that combines a multitude of functional and decorative duties. However, all you need do is look at the scales above and remember—zinc die casting gives you more for less. How else would you make it?

Zinc die castings by Paragon Die Casting Company, Chicago, Illinois.

NJZ

THE NEW JERSEY ZINC CO.
160 FRONT STREET • NEW YORK 38, N. Y.

For more information, turn to Reader Service card, circle No. 417

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NEXT MONTH

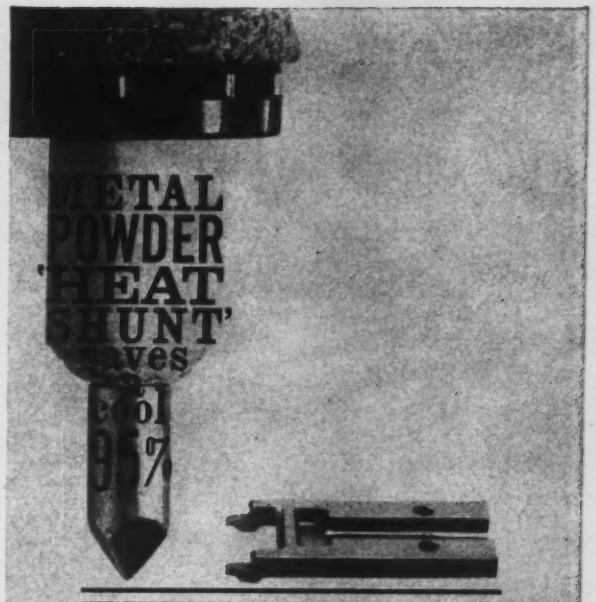
Progress in High Temperature Coatings . . . A series of five articles on one of today's most pressing engineering problems. Topics include coatings from the plasma arc . . . coatings for the refractory metals . . . new diffusion coatings . . . ablative coatings.

Value Engineering . . . The systematic approach to meeting engineering requirements at minimum cost. How to make a value analysis, how to set up a value engineering program, and how it can help in selecting the best material and process for a particular application.

Specifying Tubing for Cold Forming . . . Most small metal tubing is cold formed at some point. Here are eight factors you should consider in selecting the tubing material.

Ultra High Temperature Textiles . . . How far have we come in closing the formidable gap between the present 500 F limit of usefulness and the 2000 F capability we need? The authors summarize what has been achieved and suggest the direction of future work.

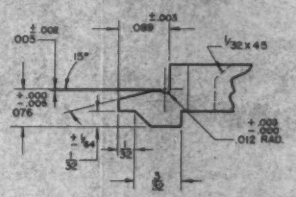
This Month's Cover: *Artist's conception of interstitial solid solution alloy by Wayne Trapp.*



The heat shunt shown above is pressed from pre-alloyed bronze powder and hard-chrome plated. It is used to position electronic components on printed circuit boards and eliminate heat damage when soldering.

Design teamwork between Kwikset Powdered Metal Products and Autonetics Division of North American Aviation has resulted in a part which is produced at a 95% cost saving over previous machining methods.

The heat shunt is easily produced in four precise end modifications to locate components at various angles. When soldering,



the high heat conductivity of the bronze protects the components and circuit from melting by drawing off heat produced at the solder joint. The heat shunt itself is solderproof thanks to its hard-chrome plate.

This time-saving printed circuit tool demonstrates that, working together, the metal powder fabricator and his customer can lick the hottest problem. To find out how to put nonferrous powder metallurgy to work for you, write today to the New Jersey Zinc Company, producers of nonferrous metal powders setting tomorrow's standards today.

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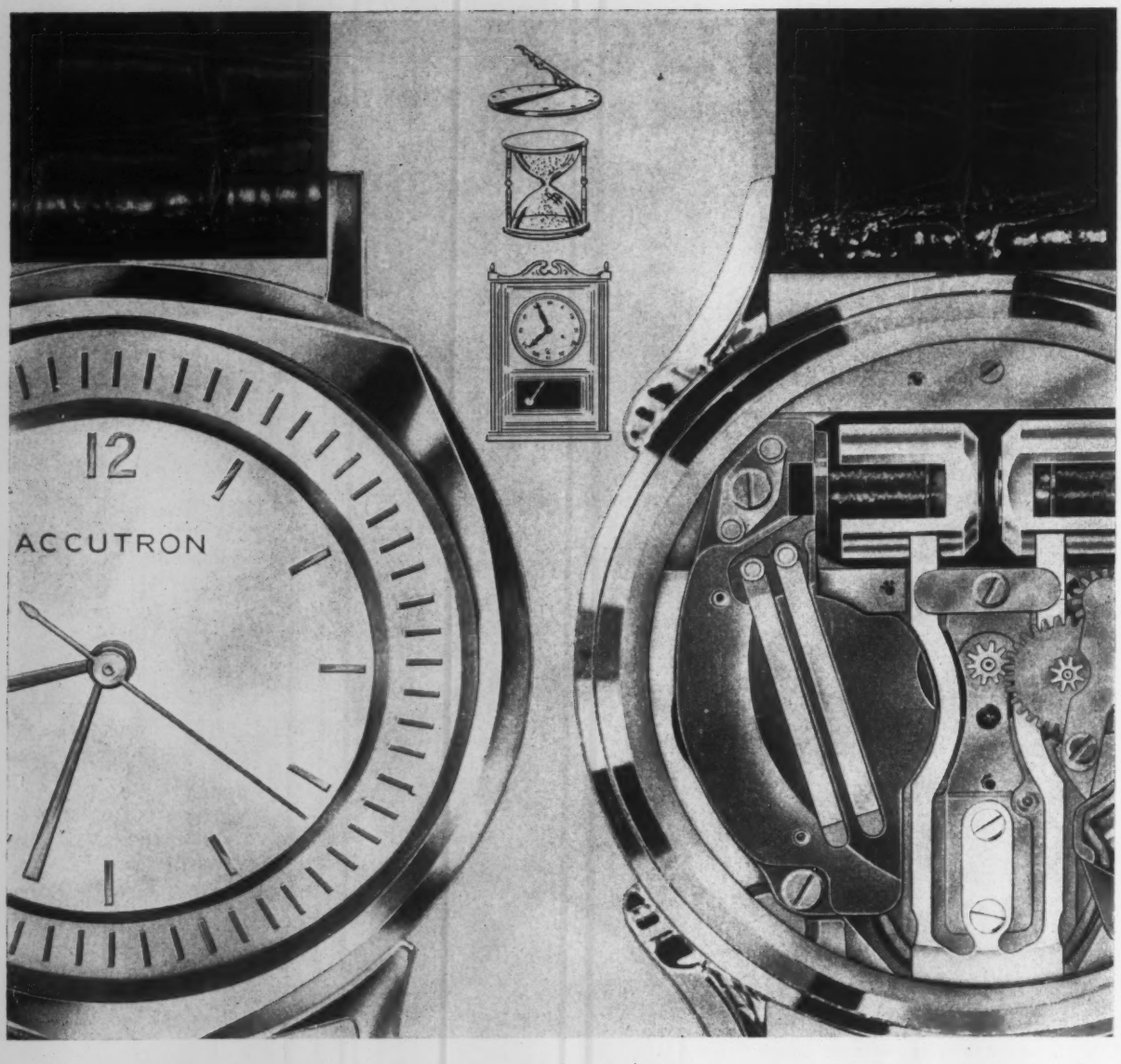

How Nickel helps make timekeeping history

Electronic tuning fork made of a Nickel alloy represents the most basic advance in personal timekeeping in 300 years

A watch you don't need to wind. A watch without mainspring, balance wheel, or hairspring. A watch that doesn't gain or lose more than 2 seconds out of every 86,400!

The secret of the fantastic timekeeping accuracy of Accutron* is a precision tuning fork that vibrates more than 31 million times every twenty-four hours—day after day, week after week, month after month...powered by a button-size battery.

To assure the faultless, electronic measurement of time, the tuning fork's incessant vibration must remain constant under a wide range of temperatures and all sorts of shock and impact that can occur in day-to-day watch wear.

That's why electronic engineers chose Ni-Span-C† alloy (42% Nickel) for the heart of this space-age marvel. This high Nickel alloy maintains the fork's vital stiffness at temperatures from 0° to 150° F...fights off damaging corrosion and oxidation.

Just as Nickel helps give this watch's mechanism exceptional reliability, so too Nickel can increase the reliability of hundreds of alloys under many severe conditions—great heat, cold, corrosion, or stress. Alone, or with other elements, Nickel gives alloys the combination of properties to meet the most demanding metals needs.

Perhaps Nickel or a Nickel alloy can help solve your metal problem. To find out, just write to Inco.

*Bulova Watch Company, Inc. trademark.
†Registered trademark, Inco.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO NICKEL

MAKES ALLOYS PERFORM BETTER LONGER

An economical grade of stainless steel for fasteners has fabricating and corrosion resistance properties similar to those of more expensive grades of high nickel alloys but sells for 13¢ per lb less. The new material is available as billets, hot and cold finished bars, hot rolled rods and cold drawn wire.
Source: Armco Steel Corp., Middletown, Ohio.

Parts made of a new alumina-silicon carbide compound are said to have better strength, hardness and corrosion resistance at elevated temperatures than presently available alumina ceramics. The material can be used as an insulator or as a conductor by varying the silicon carbide content. Hot pressed parts are available on special order.
Source: Diamonite Products Mfg. Co., Shreve, Ohio.

A new grade of lighter, thinner tin plate is priced 15¢ per base box lower in all basis weights than presently available material. The new grade, now available, has a coating of 0.1 lb tin per base box. Heretofore, thin tin plate was produced in one grade only with 0.25 lb of tin per base box. Potential uses: cans for citrus juices, motor oil.
Source: U.S. Steel Corp., 525 Wm. Penn Pl., Pittsburgh 30.

A new dry bearing material—graphite fabric impregnated with TFE fluorocarbon plastic—is said to be highly promising for sliding and thrust sleeve bearings used in small, high speed motors and appliances. Compared to other dry bearing materials, the composite is said to result in higher permissible operating temperatures, lower frictional values and lower cost. PV limits are said to be 10,000 for a shaft velocity of 10 fpm and 30,000 for 50 fpm and over.

Extruded tubular shapes of stainless steel having a wide variety of exterior and interior configurations are now available. The producer uses a variation of the French-developed Ugine Sejournet process to make the shapes: a billet is induction heated, coated with powdered glass, and then driven through a die by a high speed hydraulic extrusion press. A ram in the center of the die produces the hollow bore of the shape.
Source: H.M. Harper Co., Metals Div., Morton Grove, Ill.

New types of tailor-made plastics, called "structoset" polymers, are under development. They include network polymers such as urethanes, thermoset acrylics, polyesters and epoxies. The materials can be produced with predeterminable mechanical, electrical or thermal properties, or combinations of properties. Essentially, the materials are formed by chemically crosslinking carefully "constructed" and well-defined low molecular segments (prepolymers) with or without the use of heat. The low-molecular-weight prepolymers are low in viscosity, soluble, and easy to handle.
Source: E. E. Hardy and S. H. Rider, Monsanto Chemical Co., paper presented at American Chemical Society annual meeting, Sept '61.

90-inch seven-stage bit used by Kerr-McGee Oil Industries is the business end of an installation which includes the Allen-Sherman-Hoff materials-handling centrifugal pump. Pump is lined with Hycar molded by A-S-H Molded Products Company. B.F.Goodrich Chemical Company supplies the Hycar nitrile rubber.

Hycar lined pump delivers 8,000 gpm of mud to giant-sized rotary drill

Oil field technology is giving a boost to another industry—mining—with this tremendous rotary drill. It is excavating a 90″ hole 700 feet deep, equivalent of moving earth from a 12″ hole 40,000 feet deep.

Providing a continuous mud supply is a real job—the centrifugal pump being used has a rating of 7,000 gpm with a discharge head of 110 feet. Up to 8,000 gpm are obtained in operation. The pump is lined with Hycar nitrile rubber—chosen to protect the pump housing against the torrent of sharp rock chips carried by the mud circulated during the drilling operation.

Hycar is often the choice for oil field jobs—it performs excellently under both high and low temperature conditions, it resists corrosion, chemicals and hydrocarbons in a manner unmatched by other rubbers. It will pay you to see that Hycar is used in all your operations. For more information, write Department **MI-4,** B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. In Canada: Kitchener, Ontario.

B.F.Goodrich Chemical

a division of The B.F.Goodrich Company

Hycar

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Rubber and Latex

For more information, turn to Reader Service card, circle No. 331

Aluminum sheet and foil can be permanently vulcanized to rubber, thus combining the corrosion resistance and insulation values of aluminum with the flexibilty of rubber. The process is made possible by a special aluminum coating, composition of which has not been revealed. The producer applies the coating to sheet and foil and ships the coated metal as coils.

Source: Reynolds Metals Co., Richmond 18, Va.

Long-discussed EP rubber, a copolymer of ethylene and propylene, is being commercially introduced at 26¢ per lb. Claims made for the new synthetic elastomer include outstanding resistance to ozone, weathering and chemicals. (More details next month.)

Source: Enjay Chemical Co., 15 W. 51st St., New York 19.

Cutting tools made of a new tungsten carbide machine hard-to-form, heat resistant alloys at higher speeds than conventional grades. The carbide is said to have a "considerably finer grain structure than any carbide now available."

Source: Hoy Carbides Ltd., Inca Works, Saunderton, High Wycombe, Buckinghamshire, England.

A new beryllium copper alloy is highly resistant to salt water corrosion and has strength and hardness that enable it to withstand continuous pressures of 12,000 psi when fabricated into thin-walled parts. A big use for the alloy will be casings and couplings in a new underwater telephone cable system. Yield strength (0.2% offset) is 140,000 psi; tensile strength, 160,000 psi; and elongation (in 1.4 in.), 2.5%.

Source: Beryllium Corp., P. O. Box 1462, Reading, Pa.

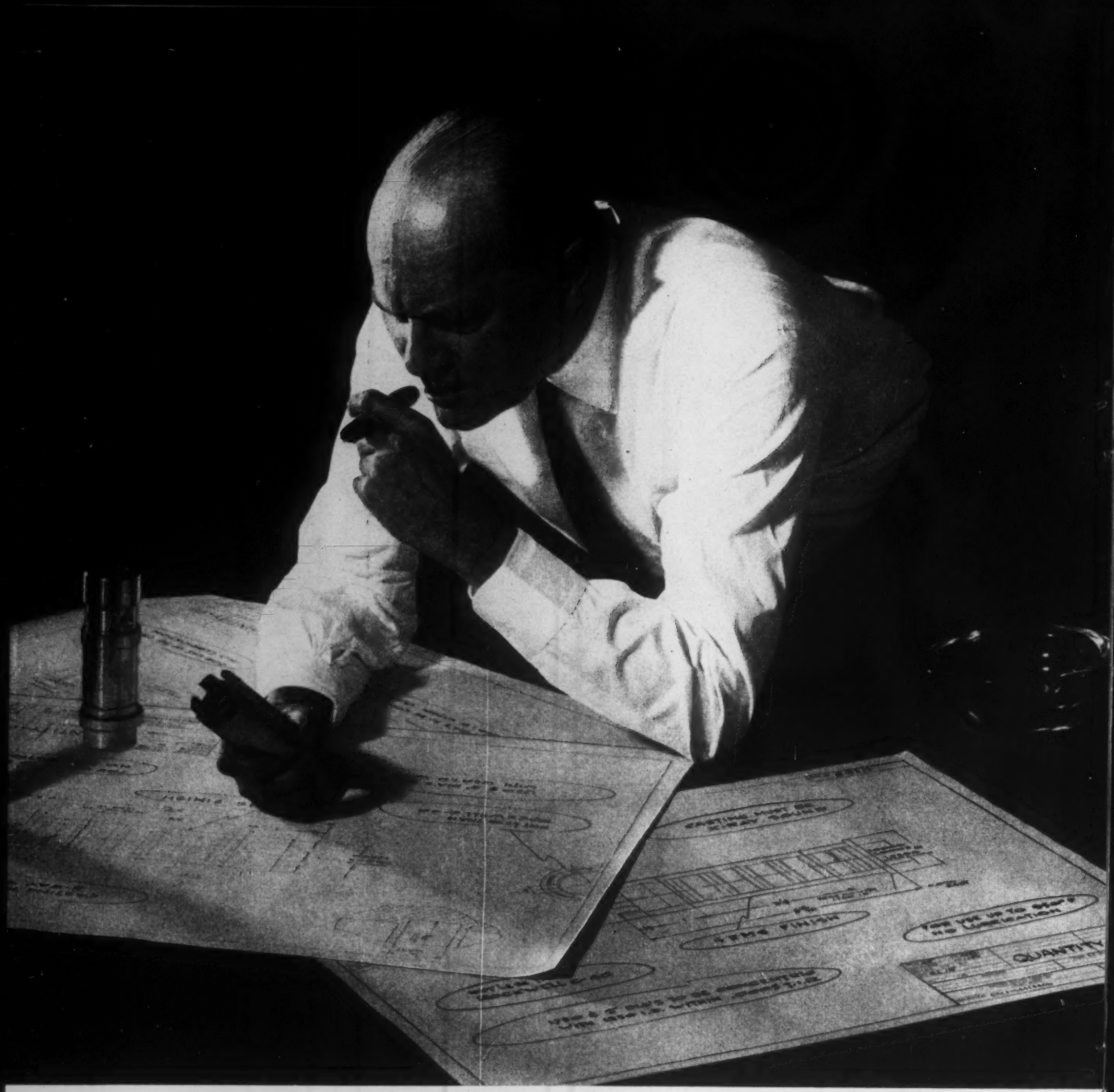
An easy way to deposit cermet coatings on metal and nonmetallic parts is to electrodeposit various ceramics in a chromium matrix by fairly conventional plating techniques. Advantages: 1) control of the electroplating solution is relatively easy; 2) thickness of the electroplate can be controlled to 0.001 in.; 3) the process is adaptable to any shape; and 4) the deposited coating requires no machining or mechanical finishing. Recent test firings of a solid propellant graphite rocket nozzle protected with an electrodeposit of zirconium boride and chromium show the coating has good erosion resistance at high temperatures.

Source: Value Engineering Co., 2320 Jefferson Davis Hwy., Alexandria, Va.

A new aluminum alloy for light reflectors is said to have excellent formability. Supplied as circular sheets up to 60 in. in dia, the material is available in the O and H25 tempers in mill finish. The sheet has no cladding and thus eliminates the problem that arises with conventionally used clad sheet when buffing removes cladding on severely contoured surfaces.

Source: Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19.

Turn to page 9 for more "What's New in Materials"



I need a bushing that will last more than a month!

His problem: Metal-to-Metal wear that led to seizing and galling and then . . . quick failure. His remedy? Well, the use of a HAYNES cobalt-base alloy could be the answer.

These alloys have low coefficients of friction and are unusually long lasting under Metal-to-Metal wear conditions . . . ideal for bushings and sleeves. And they can be supplied in the exact shape, to the exact dimensions, and with the type finish needed to do the job.

But HAYNES alloys can do more than solve bushing problems. They are used universally . . . wherever metal parts that must take a beating are required. To help you get acquainted with the characteristics of these alloys, write for our 32 page book.

HAYNES
ALLOYS

HAYNES STELLITE COMPANY

Division of
Union Carbide Corporation,
Kokomo, Indiana

UNION CARBIDE

Address Inquiries to Haynes Stellite Company, 270 Park Avenue, New York 17, New York

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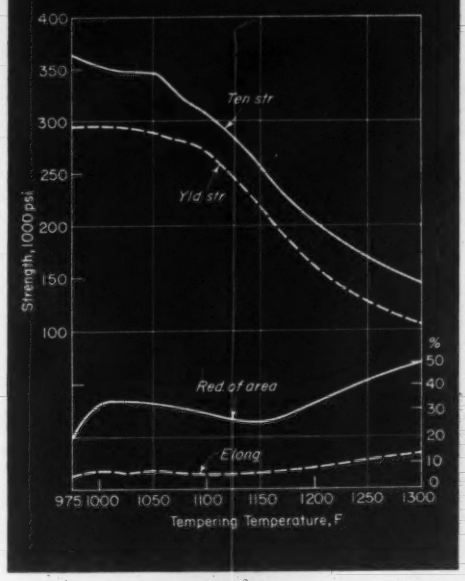


Tempering temperature *affects mechanical properties of Vascojet M-A. Specimens were austenitized at 2050 F for 5 min and triple tempered (2 hr each time) at indicated temperatures from 975 to 1300 F.*

New Ultra High Strength Steel

for fasteners, airframes, axles, gears, rotors

■ A new medium alloy steel has been added to the growing number of ultra high strength steels being made available to engineers and designers. Called Vascojet M-A, the steel is consumable vacuum arc melted to provide more ductility and a smaller differential between longitudinal and transverse mechanical properties.

The new steel has a high strength-to-weight ratio; at 600 F, the figure is 850,000 in., compared to 610,000 for Ti-6Al-4V.

According to the developers, Vanadium-Alloys Steel Co., Latrobe, Pa., fabricability of the new steel is similar to that of Vascojet 1000. Forming, machining and forging are preformed on annealed material that is subsequently hardened in conventional protective atmosphere furnaces.

Composition of the steel has not been divulged.

Yield is 290,000 psi

The accompanying graph shows how mechanical properties vary with tempering temperature. Maximum yield strength of 290,000 psi is combined with 5% elongation.

At 350,000 psi tensile strength the steel has a fatigue life of 342,000 cycles at 170,000 psi stress and 1,467,000 cycles at 150,000 psi stress. Charpy V-notch impact strength is 8 ft-lb when tensile strength is 345,000 psi; tempering back to 300,000 psi tensile strength raises impact strength to 12 ft-lb.

Use inert atmosphere

Vascojet M-A must be heat treated in a protective atmosphere. It is austenitized at 2025 to 2050 F for 5 to 10 min after reaching temperature, then quenched in air or salt. Oil is used to quench heavy sections.

Triple tempering at 975 to 1200 F for 1 to 4 hr is time consuming but many advantages accrue:

1. Optimum stress relief is combined with maximum hardness because tempering is done in the secondary hardening temperature range, i.e., the range in which the steel develops a higher hardness than at a lower temperature.

2. Hydrogen, which can cause embrittlement when tensile strength exceeds 300,000 psi, is rapidly removed and strength is not lowered.

3. Retained austenite is transformed, reducing the danger of subsequent transformation to martensite with accompanying high stresses during service.

Many potential uses

Vascojet M-A appears suitable for applications requiring extremely high strength combined with ductility, toughness, fatigue and heat resistance. According to Vanadium-Alloys, such applications may include high strength fasteners, airframe structures, rocket motor cases, high speed rotors, torsion bars, lightweight axles, gears and shafting, pressure vessels and helicopter rotors.

Available forms include billets, forgings, sheet, plate, bars and wire in all common sizes. Base price of bars is $1.865 per lb.

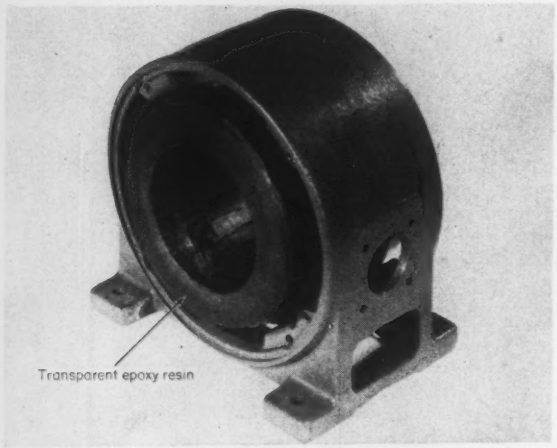
For more information circle No. 600

New Epoxy Encapsulating Resin

is transparent . . . resists mechanical and thermal shock

■ High resistance to thermal and mechanical stresses is provided by a new semiflexible, transparent epoxy encapsulating and impregnating resin developed by Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Designed for Class B (130 C, 266 F) operation, the resin retains its flexibility (70D Shore hardness) over a temperature range of —67 to 266 F. It is expected to be especially useful for encapsulating motor stators (see photo), coils and transformers; for potting connectors; and as a coating for printed circuit boards.

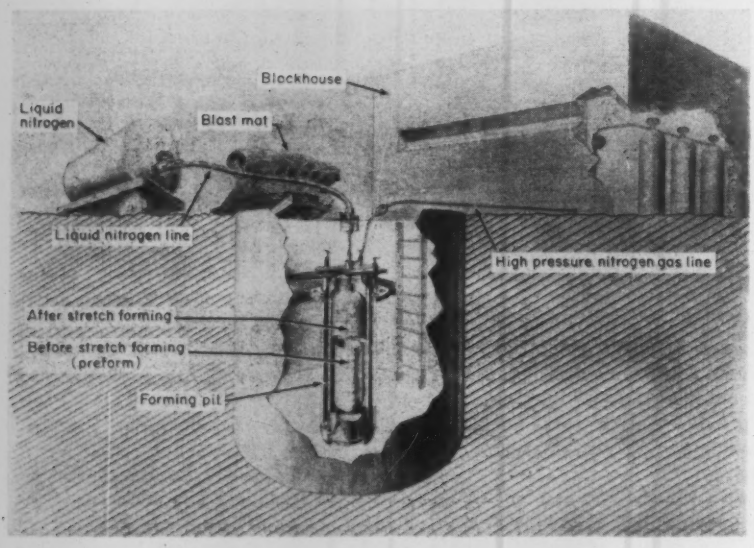


***Motor** stator windings are visible through epoxy encapsulant after cure.*

Because of its low exothermic heat rise during curing the resin (called Scotchcast brand electrical resin No. 8) can be used to pot and encapsulate heat sensitive components at room temperature. In typical tests a 100-gm sample of the resin cured in a paper cup reached a peak temperature of only 168 F during curing, as compared to 325 F reached by another at room-cure epoxy resin processed under the same conditions. Cure temperature is expected to be even lower when encapsulating components since the components act as heat sinks and help reduce curing temperature.

The 100% solids, two-part resin is said to be easy to handle. It is mixed in a ratio of 1 to 1 by weight, producing a specific gravity of 1.11. Initial viscosity at room temperature is 5700 sec and pot life is 1 to 2 hr. Normally an overnight cure is required when curing at room temperature; however, curing temperature can be shortened by heating for 2 hr at 140 F. After curing, the resin has an electric strength of 400 v per mil. **For more information circle No. 601**

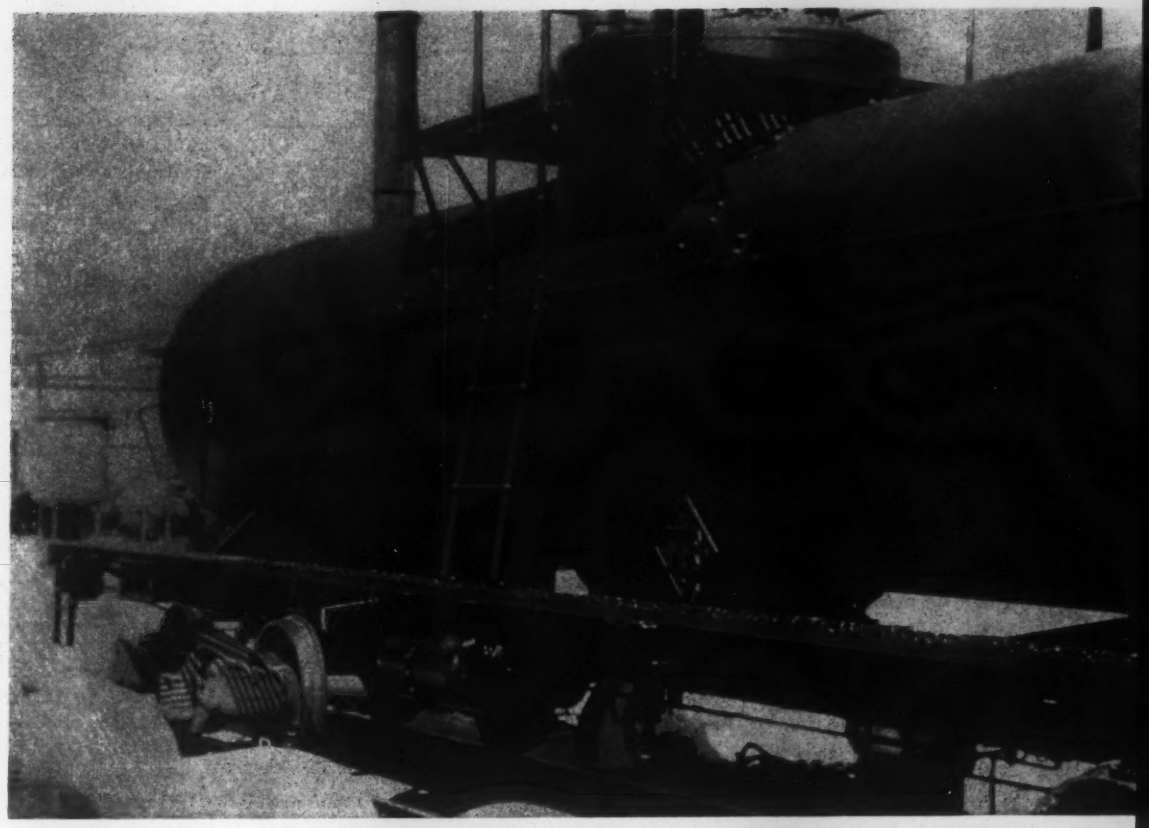
Cold Stretching Makes Stronger Tanks



■ Stainless steel tanks stretched at liquid nitrogen temperature gain significantly in tensile strength (260,000 psi vs 102,000 psi). The cutaway view of the forming pit at left shows how Arde-Portland, Inc., 100 W. Century Rd., Paramus, N. J., accomplishes this operation which it calls Ardeform.

The first step is to fill the forming pit and preformed tank with liquid nitrogen. After the preform reaches liquid nitrogen temperature (—320 F), the liquid nitrogen line is removed and a high pressure nitrogen gas line from the blockhouse is attached. Pressurization of the liquid nitrogen stretches the preform tank approximately 13%. (For more specific information on why Ardeforming increases the tensile strength of the tank, see "New Ways to Strengthen Metals" on p 115 of this issue.)

For more information circle No. 602



Tank car *exterior is coated with 15 to 20 mils of polyester to protect against caustics and weathering.*

Polyester Coatings for Metals

provide high resistance to weathering, water and chemicals. They are relatively inexpensive and can be applied up to 15 mils thick in one spray coat.

by Neil S. Estrada and Lawrence Graubart, *Pacific Central Div., Reichhold Chemicals, Inc.*

■ Polyester resins are now available in coating form for protecting and decorating metal products. Like their counterpart resins—which have had a successful history in plastics laminates and moldings—polyester coating resins provide excellent outdoor durability, good resistance to water and salt spray, and high resistance to many chemicals. They are also noted for their good mechanical properties, especially their resistance to impact and abrasion and their good flexibility.

Unlike most conventional coatings the polyesters do not require a solvent for application. This is an important advantage because it permits coatings to be applied as 100% "solids" in thicknesses up to 15 mils in one coat, even on vertical surfaces. Application is relatively easy using a dual-head spray gun; however, coatings must be applied over a well prepared surface and a special primer. The coatings cure at ambient temperature.

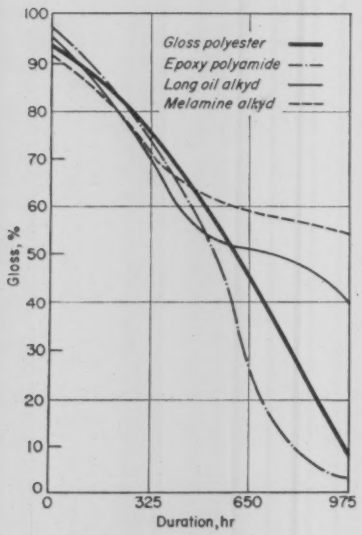
Protective and decorative

Depending on the application, you can obtain these coatings in both protective and decorative types. *(continued on next page)*

▸ The protective type is available in a number of colors in a low gloss finish and is claimed to be less expensive than epoxies, vinyls and other specialized coatings used for corrosion protection. It is particularly recommended for outdoor use on tank cars, storage tanks, piping and valves, ship hulls, metal signs, and industrial processing equipment.

▸ The decorative type is available in a wider range of surface finishes for use where better appearance and less protection is required—especially appliances and industrial products for indoor use, where its ability to cover in one coat is of special advantage. It can be cured at elevated temperatures where desirable.

Typical applications are illustrated by the accompanying photographs. Another noteworthy application is a large, 8000-gal storage tank that contains tall oil fatty acids at 130 F. Complete protection for over one year has been obtained by coating the interior with polyester paint applied over a sandblasted and primed surface. A similar coating system has been successfully used on the interior of a tank containing polyvinyl acetate emulsion.



***Gloss retention** of polyester coating and competitive organic coatings after Weatherometer tests.*

TABLE 1—GENERAL PROPERTIES OF POLYESTER COATINGS

Type →	High-Gloss Decorative	Low-Luster Protective
Abrasion Resistance	Exc	Exc
Direct Impact Resistance	Good	Good
Weather Resistance	VGood[a]	VGood[a]
Water Resistance	Good	Exc
Acid Resistance	VGood	VGood
Alkali Resistance	Fair	Fair
Solvent Resistance	VGood	VGood
Dielectric Str, v/mil	500-800	500-800

[a]Fails by slow chalk.

Cost is lower

The cost of polyester coatings is lower than that of alkyd resin coatings generally used for metal protection, and much lower than that of epoxies, vinyls and other specialized resins used for corrosion protection. Also, the short bake cycle required (10-15 min at 200 F) helps to lower cost by reducing the amount of heat required, shortening production time, and eliminating long conveyor systems.

Although the materials cost of decorative, gloss-producing polyesters is higher, it compares favorably with that of conventional decorative organic coatings. Applied cost of the decorative coatings is low, primarily because heavy coatings are easy to apply and cure rapidly.

Differ from alkyds

Polyester coatings are made up of the reaction products of three materials:

1. Dihydric alcohols (propylene glycol).

2. Unsaturated dibasic acid anhydrides (maleic anhydride).

3. Saturated dibasic acid anhydrides (phthalic anhydride).

Various other materials can be added to these basic materials to achieve better properties. Adipic acid, for example, can be added for flexibility, and isophthalic acid for greater chemical stability.

Polyester resins bear some resemblance to alkyd coating resins but differ chemically in that the unsaturated groups provided by the drying oils in alkyd are replaced by those in maleic anhydride and styrene. They also cure differently. Alkyds dry or cure by oxidation and polymerization aided by driers or by baking. Polyesters, however, are dissolved in styrene (an unsaturated monomer) and are cured by incorporating peroxide catalysts which form free radicals at either room or elevated temperature, depending on the application.

The free radical nature of the polyester curing mechanism is unique among film formers. Oil-modified alkyds, for example, must be applied from solution. Catalyzed systems such as the epoxies and the urethanes require very intimate mixing of precisely metered quantities of reactants to develop optimum properties; this often requires highly specialized equipment and raises application costs. Polyesters, in contrast, need no intimate mixing and it is entirely feasible to spray polyester and catalyst from dual-head spray guns and obtain a complete cure. Normal spray techniques can be used.

Durability compared

Tables 1 and 2 show how the two types of polyester coatings compare with each other and with other coating systems. Note that the polyester paints exhibit excellent durability outdoors. Exposure tests in Florida and Arizona show that the gloss retention of decorative polyesters is superior to that of epoxy enamels and compares favorably to that of baked enamels (see graph for Weatherometer results). The decorative polyesters also have good color retention and their yellowing tendency is well within acceptable limits.

Salt spray resistance — Salt spray exposure tests have been run for 300 hr at 110 F using a 20% salt solution. They show that polyester paints provide equal or better protection than conventional coating systems. Best performance is provided by a semigloss polyester paint which, even after exposure for 900 hr, shows remarkably good resistance to rusting at

X-type score marks.

Water resistance — Immersion tests in distilled water for 22 days at 77 F did not affect semigloss polyester paint. (Similar tests also showed no effect on epoxy and vinyl systems.) Immersion in boiling water and detergent solution for 8 hr at 180 F produced only slight blistering of polyester (and epoxy) paints.

Chemical resistance—As shown in Table 2, the only chemical reagent that affects the protective low-gloss polyester paint is sodium hydroxide. However, this reagent only produces a superficial etching of the film and does not prevent it from maintaining complete protection. The coatings have excellent resistance to Skydrol hydraulic fluid, fatty acids and strong acids. A negligible amount of surface dulling is caused by commercial bleach solution. Hydrochloric acid produces a slight color change due to its reaction with the cobalt that is part of the formulation.

Mechanical properties — The mechanical properties of the two polyester paint systems are also quite good. The coatings withstand a direct impact of 30 in-lb and have satisfactory flexibility considering their heavy film thickness. Abrasion resistance is very good. Film hardness can be adjusted from 15 to 60 Sward, depending on the composition selected and end-use requirements. Tensile strength of protective-type semigloss polyester paint films is about 8000 psi, flexural strength about 15,000 psi.

Application is simple

Like any other coating system, polyester should be applied over thoroughly clean metal. Furthermore, to provide good adhesion and insure corrosion resistance, you should prime the metal with an epoxy-polyamide, zinc chromate system, 0.5 to 1 mil thick. Apply it immediately after sandblasting and allow it to cure for about one day.

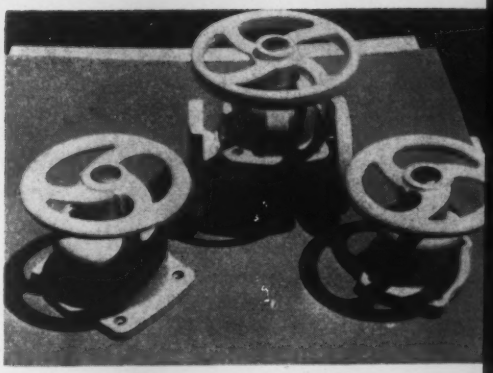
It is recommended that the polyester topcoat be applied with a dual-spray gun. One gun supplies polyester paint with peroxide catalyst (usually a 60% active solution of methyl ethyl ketone peroxide in dimethyl phthalate). The other gun supplies polyester paint containing a promoter (usually a cobalt naphthenate solution) to decompose the peroxide.

Adjusting the reacting proportions is extremely simple. An excess of either component does not affect overall composition of the paint since the paint coming through both guns is essentially the same (imbalances as much as 10 to 20% of either component can be tolerated). Also, moderate variations in the proportions of catalysts and promoter only cause a slower rate of cure, thanks to the free-radical nature of the cure.

The usual multi-mil spray technique is used. Lack of volatile solvents reduces the atomization problem associated with conventional paints, and higher film thicknesses can be produced in one spray application. Polyester paints can be readily made thixotropic so that single coats up to 15 mils thick can be applied on vertical surfaces without danger of sagging or running.

Spray application is not mandatory; you can use brush or roller provided you take care to avoid resin gelation. "Curtain coating" of relatively flat surfaces is also practical: use two curtains in tandem, one applying resin with catalyst and the other resin with promoter. This technique produces minimal mixing but, because of the free-radical nature of the cure, the coatings convert properly.

For more information circle No. 603



***Valve parts** are coated both inside and outside with 10 to 15 mils of polyester for corrosion protection.*

TABLE 2—COMPARATIVE CHEMICAL RESISTANCE OF POLYESTER COATINGS[a]

Coating →	High-Gloss Decorative Polyester	Low-Luster Protective Polyester	Conventional Alkyd[b]	Long Oil Iso-Alkyd	Epoxy-Polyamide	Epoxy-Amine[c]	Vinyl
10% Sodium Hydroxide	Severe dull	Mod dull	Destroyed	Destroyed	No effect	No effect	No effect
28% Ammonium Hydroxide	Severe discol	VSI discol	Severe dull	Severe discol, si wrink	No effect	No effect	No effect
50% Sulfuric Acid	Mod dull	No effect	Severe dull	No effect	SI discol, sl dull	No effect	No effect
50% Acetic Acid	VSI blist	No effect	Mod blist	Mod wrink	Severe blist	Severe blist	SI blist
50% Nitric Acid	Mod dull	VSI discol	Severe blist, severe discol	Wrink, discol	Severe blist, severe discol	Severe discol, Mod blist	SI effect
50% Hydrochloric Acid	SI dull, sl discol	VSI discol	Severe dull	SI discol, sl wrink	No effect	Blist	No effect
Linseed Fatty Acid	No effect	No effect	Severe wrink	Severe wrink	Severe discol, mod dull	No effect	No effect
Commercial Bleach	Severe dull	SI dull	Severe dull	Severe dull	Mod dull	Severe dull	No effect
Hydraulic Fluid[d]	No effect	No effect	Destroyed	Severe wrink	No effect	No effect	Destroyed

[a]24-hr exposure at 75 F. Coatings applied over sandblasted and primed steel. [b]TT-V-81b. [c]TETA. [d]Skydrol 7000.

Fluorosilicone Fluids

These new fluids, compounds and greases are useful in lubrication, hydraulics, damping, etc. where tough solvents are encountered.

■ A new family of functional fluids—fluorosilicones—has been announced by Dow Corning Corp., Midland, Mich. The fluids, greases and compounds extend the utility of silicone fluids to applications where problems of chemical compatibility and solubility have limited their use. The new fluids have much better room temperature lubricity than other silicone fluids. They are generally serviceable from –40 to 400 F.

At present, the family consists of 1) three fluids of differing viscosities, 2) two compounds (fluids thickened with finely divided silica filler) of differing solvent resistance and thickening temperatures, and 3) two greases (fluids thickened with a lithium soap) of differing low temperature and wear resistance characteristics.

Lubricants, hydraulic fluids

The fluid, designated FS 1265, is available in viscosities of 250, 1000 and 10,000 cs. General physical properties are shown in Table 1; solubility in various solvents is given in Table 2.

Uses for the fluids include:

1. Lubricants for high and low temperatures and extreme pressures where requirements demand insolubility in fuels, oils, solvents.
2. Hydraulic fluids for high and low temperature service.
3. Compressor oils.
4. Flotation and damping fluids.
5. Defoamers, since the fluids are nonfoaming.

Lubricity of the new silicone fluids at room temperature is substantially better than that of conventional silicones (see curves). Thermal stability is excellent.

Preliminary tests indicate the fluid has excellent stability in the presence of liquid oxygen. With the ABMA Impact Tester, the 10,000-cs fluid showed no detonation in 20 test drops at 70 ft-lb.

Price of the fluid ranges from $6 for a 2-oz bottle to $25 per lb for 50-lb quantities (5-gal can).

Compounds and greases

Properties of the two compounds and two greases are shown in Table 3. Solubility of the two compounds is given in Table 4.

The compounds, FS 1280 and 1281, are specifically intended as lubricants for fuel, oil and solvent resistant valves, where extremes of heat and cold are encountered. They are also expected to find uses as sealing materials and as lubricants for low speed bearings. They are serviceable from –80 to 400 F, and show little attack on most rubber seals.

TABLE 1—PROPERTIES OF FLUOROSILICONE FLUIDS

Viscosity (77 F), cs ➡	250	1,000	10,000
Color	...Water white to straw...		
Viscosity, 1000 cs			
At 0 F	3.9	22.0	440.0
At 100 F	0.14	0.51	5.4
At 210 F	0.024	0.074	0.690
At 400 F	0.005	0.0115	0.0080
Specific Gravity (77 F)	1.24	1.28	1.30
Freeze Point, F	–60	–40	–25
Flash Point (open cup), F	440	530	530
Fire Point, F	530	>620	>620
Volatility, % by wt[a]			
4 Hr at 392 F	4.1	1.5	1.5
48 Hr at 392 F	13.5	3.1	3.0
120 Hr at 392 F	20.0	5.0	4.9
240 Hr at 392 F	25.0	8.0	6.0
Gel Time, hr at 392 F[a]	350	350	350
Acid Number	Trace	Trace	Trace
Surface Tension, dynes/cm	25.7	26.1	28.7
Coef of Ther Exp (77-390 F), per °F	.....0.527×10^{-3}.....		
Compressibility, %[b]	.....7.28.....		

[a]Determined by heating 35-40 gm of fluid in air circulating oven; fluid contained in 150-ml beaker having a bottom area of about 3 sq in.
[b]At 20,000 psi.

TABLE 2—SOLUBILITY OF FS 1265 FLUID[a] (1000-Cs Grade)

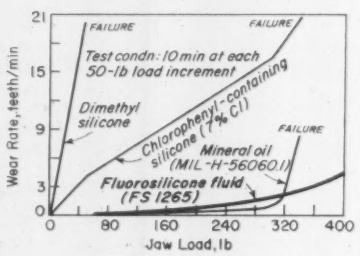
Solvent ⬇ Grade ➡	250 Cs	1000 Cs	10,000 Cs
Isopropyl Alcohol	I	I	I
Ethylene Glycol	I	I	I
Propylene Glycol	I	I	I
Iso-Octane	I	I	I
VM & P Naphtha	I	I	I
JP-4 Jet Fuel	I	I	I
Benzene	D	sl D	sl D
Xylene	sl D	sl D	sl D
Styrene	D	sl D	sl D
Freon 11	S	sl S	I
Freon 12	S	I	I
Freon 114	S	I	I
Perchloroethylene	sl D	sl D	sl D
Chlorothene	S	sl S	D
Methylene Chloride	S	S	sl S
Methyl Ethyl Ketone	S	S	S
Acetone	S	S	S
Methyl Isobutyl Ketone	S	S	S

[a]I=insoluble; sl S=slightly soluble; S=soluble; D=insoluble but dispersible; sl D=insoluble but slightly dispersible.

TABLE 4—SOLUBILITY OF COMPOUNDS (%)[a]

Type ➡	FS 1280	FS 1281
MIL-H-3136—Type II	6	19
JP-4	Nil	12
Kerosene	11	16
Gasoline	10	32
Benzene	4	24
Iso-Octane	0.2	16
2B Ethanol	6	6
Carbon Tetrachloride	0.6	20
Perchloroethylene	6	24
Freon 11	39	81
Tap Water	Nil	1
Acetone	80	80
Methyl Ethyl Ketone	100	99

[a]Determined according to methods specified in MIL-G-6032A for hydrocarbon fluid.



***Lubricity** improvement over conventional silicones and a mineral lubricant is shown by results of Falex wear test.*

TABLE 3—PROPERTIES OF FLUOROSILICONE COMPOUNDS AND GREASES

Material →	Compounds		Greases	
	FS 1280	FS 1281	FS 1290	FS 1291
Color	Translucent-grey	Opaque white	Opaque white	Opaque white
Penetration (ASTM D217)				
Unworked	200-240	180-220	285	285
Worked (60 strokes)	300	300	290	295
Bleed, % wt	7[a]	7[a]	0.25[b]	1.0[b]
Evaporation, % wt	2[a]	2[a]	0.9[b]	1.1[b]
Dropping Point, F	>500	>500	410	413
Est Svc Temp Range, F	−30 to 400	−80 to 400	−50 to 400	−30 to 400

[a]24 hr at 392 F. [b]24 hr at 300 F.

The greases, FS 1290 and 1291, are intended for all types of bearing lubrication where lubricity over a wide temperature range is required along with stability in the presence of splashing oils, fuels or solvents. They have better lubricating properties than any conventional silicone greases. The major differences between the two: 1) FS 1290 remains serviceable at lower temperatures (about −50 F) than FS 1291 (about −30 F), but 2) FS 1291 has slightly better anti-wear and extreme pressure lubricating properties than FS 1290.

The compounds range in price from $5-6 for a 2 oz jar to $35-40 per lb for 10-lb quantities (1-gal can). Greases range from $7 for a 2 oz jar to $46 per lb for 10-lb quantities (1-gal can).

For more information circle No. 604

11 Die Castings Combine to Cut Cost by 90%

■ The case for the counter assembly shown in Fig 1 is now produced as two zinc die castings, rather than two machined parts. In addition, all of the gears (see Fig 2), formerly machined, are now made as zinc die castings. The 11 die castings cost 91.5% less than the machined parts.

The counter assembly, used in an elapsed time indicator, weighs less than ½ oz. It was awarded first prize in the "Zinc Die Casting of the Year" competition sponsored by The New Jersey Zinc Co.

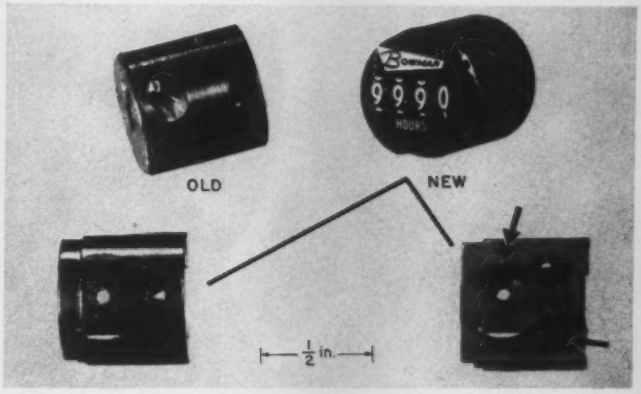
High accuracy needed

The high degree of accuracy required in such small components was the basis for the award. For example, two posts on one half of the housing must fit snugly into corresponding holes (indicated by arrows) in the other half. Hole diameter tolerance is held to ±0.0005 in. The posts therefore serve two functions: keeping the two halves of the housing firmly together, and aligning them perfectly. Dimensions of the gears shown in Fig 2 are held to ±0.001 in.

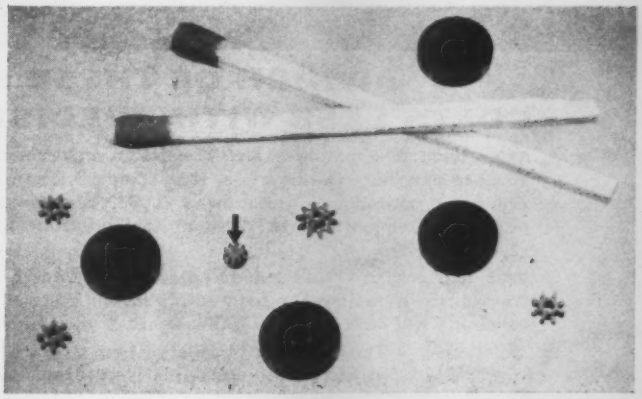
The previously used case was machined from aluminum bar stock—an expensive operation on a unit less than 1 in. long. In the new unit all openings are cast in place and the need for machining is eliminated.

More impressive, perhaps, is the array of die cast gears shown in Fig 2. These gears—the smallest is the bevel gear, 0.063 ±0.001 in. high—replace gears formerly machined from brass. All included angles are held to 15 min.

The die castings were made by Hadlock & Temte, Inc., of Chicago. The elapsed time indicator is made by Bowmar Instrument Corp., Fort Wayne, Ind.



1 *Counter assembly case (upper right) is die cast in two pieces shown at the bottom. Intricate openings were machined in old unit.*



2 *Die cast gears, formerly machined from brass bar stock, are of matchstick size. The smallest gear (arrow) —a bevel gear—is 0.063 in. high.*

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All of them, as a matter of fact. The design requirements of the finished parts may—or may not—call for closer than standard tolerances. But in an intricate, high-speed operation, a variation of 0.003" could result in costly production problems—frequent delays, constant tool adjustment, a high percentage of rejects, etc.

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Thermos Tank to Store Liquid Hydrogen

■ The aluminum sphere shown suspended here is about to be lowered into the bottom half of an outer steel jacket. The 2.5-ft thick annular space between the two shells will be filled with perlite (granular volcanic ash) and then evacuated to a pressure of 10 μ. The completed "thermos bottle" will be used for storage of liquid hydrogen.

The tank is one of several built by Douglas Aircraft Co. at its test facility for the Saturn S-IV missile at Sacramento, Calif. Chicago Bridge and Iron Co. made the steel spheres and Kaiser Aluminum & Chemical Corp. supplied the aluminum ones.

Each tank, said to be the largest of its type in the world, will hold 90,000 gal of fuel. Despite external temperatures above 100 F, the combination of insulating perlite and vacuum is expected to limit evaporation loss to 0.13% per day. At this rate it would take more than two years for a tankful to be dissipated.

The outer shell, 35 ft in dia, is made of $\frac{5}{8}$-in. plates of A285-C steel welded together. The 30-ft aluminum sphere, approx $\frac{7}{8}$ in. thick, is made of an alloy such as 5083 that resists embrittlement at –423 F.

New Flame Redardant Coating

protects metals at temperatures over 2000 F

■ A new flame and heat resistant coating that can withstand very high temperatures for long periods has been developed by Columbia Technical Corp., Woodside 77, N. Y.

The coating is specially designed to protect industrial and military equipment from the effects of heat, open flame, or sudden temperature rise, as well as to prevent the spread of fire. When exposed to heat or flame, the coating bubbles, swells and forms a protective and thermal insulating barrier.

Protective action of the coating derives from a so-called triangulated formula containing ammonium phosphate, a polyol and an amine. In addition to these three main ingredients it contains stabilizers, an additional source of carbon, and similar materials to provide thermal and mechanical stability.

Tests show that the coating, called PyroShield 21, can keep the temperature of metals below 350 F even though the coating is exposed to flame temperatures of over 2000 F for more than 1 hr. Following are some typical temperatures recorded on the protected side of the coating when exposed 5 min to a flame at 2000-2100 F:

Coat thk, mils	Metal Temp, F
20	555
50	255
75	210
95	190

Application is easy

The coating is furnished in powder form and, after mixing with water, can be applied just like conventional paint by brushing, spraying or dipping. In heavy

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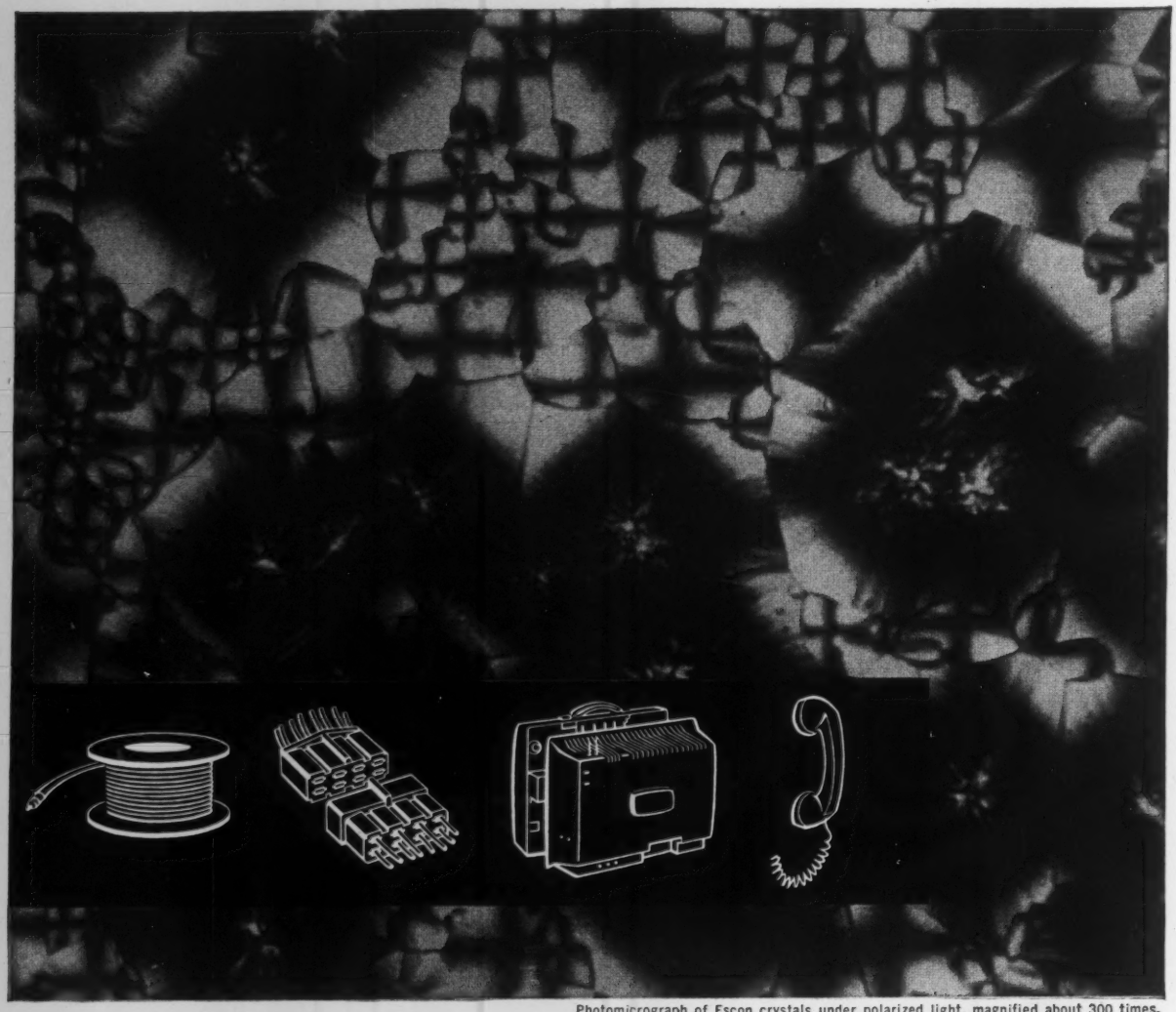

Photomicrograph of Escon crystals under polarized light, magnified about 300 times.

Escon® polypropylene for excellent electrical performance

Excellent electrical properties . . . combined with negligible water absorption and high heat distortion point . . . make Escon polypropylene particularly valuable for a wide range of electrical applications. Examples include electrical insulation, cable connectors, TV backs and telephone components. Escon polypropylene offers plastics processors a balanced combination of properties for high-speed, low-cost production. Expert technical assistance is always available. For more information write to Enjay, 15 West 51st Street, New York 19, New York.

Typical Escon Properties

water absorption, per cent	<0.01
melting point, °F	335
Vicat softening point (1 kg), °F	266-293
volume resistivity, ohm-cm	6.5×10^{16}
dielectric strength, volts/mil	
short time, ⅛" thickness	660
step-by-step, ⅛" thickness	650
dielectric constant, 10° cycles	2.0
dissipation factor, 10° cycles	0.0002-0.0003

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Magnesium Bonding, Alloying Talks Set

Current developments in adhesive bonding of magnesium will be among the subjects presented at the 17th annual convention of The Magnesium Assn. this month.

The program will also include papers on recent progress with magnesium-lithium alloys, strengthening techniques for magnesium castings, and a comparison of magnesium with other metals for dent resistance.

An exhibit of "101 Uses of Magnesium" will highlight the meeting which will be held in New York City, Oct 16-18. Further information can be obtained from The Magnesium Assn., 122 E. 42 St., New York 17.

Coppers and Alloys Finally Get Classified

After years of confusion about "commercial bronze" that is actually brass, and "nickel silver" which is a copper alloy containing no silver, wrought coppers and copper-base alloys have been classified numerically by the Copper and Brass Research Assn.

The system assigns three-digit numbers to over 100 commercially prominent wrought coppers and copper alloys. Unassigned numbers have been left for future additions in each general alloy category.

CABRA expects that, in time, the numerical designations will be used as everyday nomenclature instead of the dozens of tradenames that have often been confusing. In addition to providing prompt, accurate identification, the system is said to be usable in data processing machines.

The new list of designations will be published in a forthcoming issue of M/DE.

Chemical Engineers to Hold Materials Engineering Symposium

This year the American Institute of Chemical Engineers will include a full-day symposium on "Materials Engineering" in its annual meeting.

The program, which will be given in New York City Dec 7, will present current practices and needs of materials engineering and the technical progress being made in this area. This is the first such program within the AIChE and is recognition of the extensive work being done by chemical engineers in the field of materials development.

The meeting program:

Morning Session: Materials Engineering—The Modern Concept and Present Day Practice.

The Materials Age—H. R. Clauser, editor, MATERIALS IN DESIGN ENGINEERING.

Materials Engineering in the Electrical Industry—S. W. Herwald, vice-president, Westinghouse Electric Corp.

Product Engineering in the Chemical Industry—G. A. Hochwalt, vice-president, Monsanto Chemical Co.

Materials, the Key to Progress in Aerospace—E. M. Glass, technical director, Directorate of Materials and Processes, USAF.

Educational Programs in Materials Engineering—L. H. Van Vlack, professor of materials engineering, University of Michigan.

Afternoon Session: Future Trends in Materials Engineering.

Some Implications of Solid State Theory to Design of Inorganic Materials—E. J. Weiss, W. F. Bradley, and H. Steinfink, University of Texas.

Correlation of Molecular Structure with Engineering Properties for Organic Polymers—E. G. Bobalek, professor of chemical engineering, Case Institute of Technology.

The Systems Concept in Materials Engineering—W. R. Micks, structure and materials dept., Rand Corp.

Impact of the Structural Synthesis Concept Upon Specification of Materials—H. R. Nara, associate head of engineering division and L. A. Schmit, associate professor of structures, Case Institute of Technology.

Further information may be obtained from W. R. Collings, president, Dow Corning Corp., Midland, Mich.

Plastics Packages Approved for Cooking

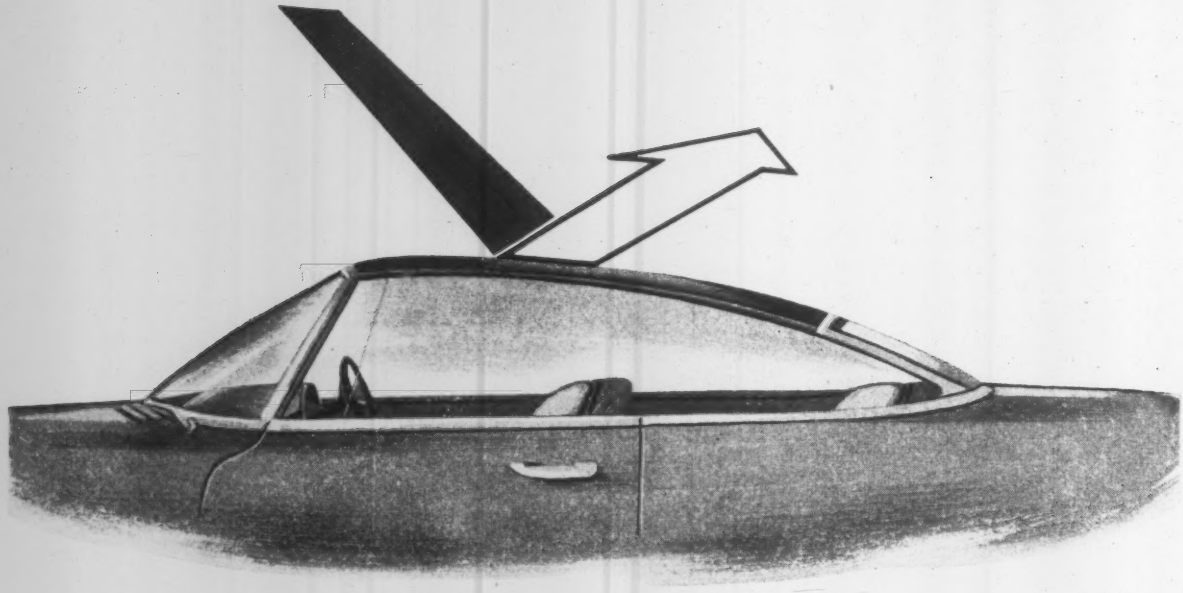
Two plastics recently received the permanent approval of the Food and Drug Administration for holding and packing food during cooking.

The use of polyethylene and ethylene-butene-1 copolymer was formally permitted by an interim regulation in June of this year. The FDA has now made this ruling permanent for ethylene-butene-1 copolymer and high density polyethylene. Low density polyethylene has not received such positive recognition, but its use is still allowed for boilable packages under the June regulation which is still in effect.

Powder Metallurgy Seeks 'Quality' Image

The powder metallurgy industry is afraid that many engineers think of its products as a "cheap substitute." It is trying to do something about it.

A committee of the Metal Powder Industries Federation headed by Kempton H. Roll, MPIF executive secretary, recently issued a "pink paper" to Federation mem-



Stop Heat Cold With Any Flexible Material—Aluminated

Your '63 car may be the coolest ever. Chances are there will be a new concept in temperature reflection under the roof . . . woven headliners combining aluminum's temperature reflectivity and light weight with fabrics' acoustical quality and good looks.

Automobile headliners—Aluminated—a new process by Thermo-Chem that impregnates any flexible material with aluminum. Alumination increases utility and widens useful temperature range by giving up to 20 times more heat (and cold) reflectivity.

Alumination doesn't crack, peel off, discolor. It won't lose its temperature-reflecting ability. And it adds strength without excess weight.

A thousand ordinary materials will soon be working in hot places they've never been before.

They can hardly wait.

Thermo-Chem Corp., 7 Noeland Ave., Penndel, Pa.

THERMO CHEM

For more information, turn to Reader Service card, circle No. 404

bers urging that they sell quality and not overemphasize cost savings.

The aim, the document indicates, is to "upgrade the consumer's view of our industry and its products."

Stress six attributes

According to the committee, the industry should stress six positive attributes of powder metallurgy parts: control; precision; quality control, tailor-made properties, the wide range of properties obtainable, and self-lubrication.

In what appears to be a reference to the postwar difficulties of the plastics industry, the document concludes: "Other industries have pulled themselves up out of the depths of overcapacity, of misapplication, of consumer ignorance. Our industry can do it too, and now is the time."

Conference on Vinyl Applications, Standards

Applications and technical standards for vinyl plastics will be the theme of a Regional Technical Conference of the Society of Plastics Engineers to be held in New York, Nov 15.

The program, entitled "Vinyl Plastics in the Household," will present some recent findings on high temperature formulations. The light stability of vinyl and the effects of processing conditions and plasticizer choice on the properties of PVC will also be discussed.

Further information can be obtained from Melvin M. Gerson, RETEC Registration Chairman, c/o Sandoz, Inc., 61 Van Dam St., New York 13.

Study Zinc-Rich Paint

A research project to study zinc-rich paints has been commissioned by the American Zinc Institute. The first goal of this work, which will be carried out by three laboratories in England, is to develop a better priming coat for automotive underbodies.

High Temperature Materials Symposium Next Month

New developments in high temperature materials will be presented at a national symposium sponsored by the Society of Aerospace Material and Process Engineers next month.

The program will cover design, processing and fabrication techniques pertinent to high temperature materials and coatings required in aerospace equipment.

Specific subjects for this meeting, which will be held in Dayton, Ohio, Nov 14 and 15, are: protective coatings for molybdenum and columbium, arc sprayed gradated coatings, reinforced refractory coatings, ceramic coatings for temperature control, graphites and their properties, and processing and properties of pyrolytic graphites.

Also: pyrolytic deposition of materials, processing and properties of ceramics for radomes, metal ceramic composites and engineering materials, bonding metal and ceramic components, and design and fabrication of refractory composite structures.

Show to Boost Costly Materials

Trends toward investing in special high-priced metals for long-range economy and toward using more plastics for industrial applications are apparent in numerous exhibits planned for next month's 28th Exposition of Chemical Industries.

The show will be held in the Coliseum in New York City, Nov 27 through Dec 1.

The state of the art of applying today's superior metals and alloys to the severe chemical industry requirements of resistance to corrosion, abrasion, high heat and stress will be demonstrated in several displays. A few examples are:

- Titanium condenser tubes
- Plasma-arc coatings
- Rotary pressure joints of many materials
- Solenoid valves for corrosive and radioactive acids

Among the many displays showing the usefulness of plastics in the chemical industries will be Teflon-lined plug valves of up to 12-in. dia and a complete line of polyethylene and polypropylene drainage fittings.

First Particleboard Standard Established

The first set of quality requirements for wood particleboard has been developed by the National Particleboard Assn. and published by the U.S. Dept. of Commerce.

The new Commercial Standard, CS236-61, is called "Mat Formed Wood Particleboard." It spells out criteria for modulus of rupture and elasticity, internal bond, linear expansion, and screw holding ability. A uniform method of grade marking panels that meet this standard with the symbol "CS236-61" is also provided for the benefit of consumers.

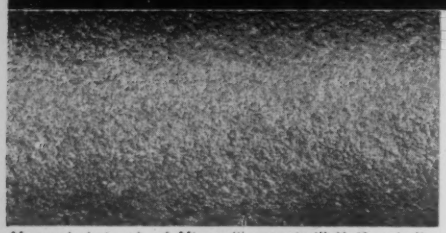
News of Societies

American Society for Testing Materials has awarded George B. Espey and Melvin H. Jones, Research Engineers, and William F. Brown, Chief, Strength of Materials Branch, NASA, the Charles B. Dudley Medal for an original paper on research and engineering materials.

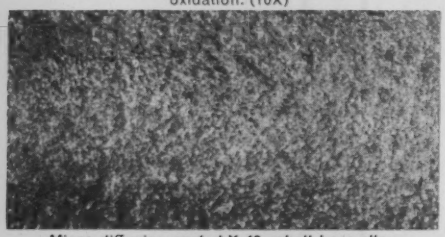
Permanent Magnet Producers Assn., has elected as president W. G. Scharnberger, Spaulding Cast Products Div., Crucible Steel Co. of America.

NOW! PROTECTIVE COATINGS FOR HIGH TEMPERATURE ENVIRONMENTS

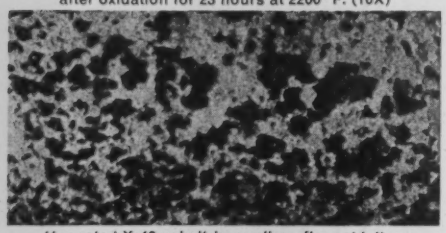
by vapor diffusion at MISCO



Macrophotograph of Misco "as coated" X-40 cobalt-base alloy, not subjected to any elevated temperature oxidation. (10X)



Misco diffusion coated X-40 cobalt-base alloy after oxidation for 23 hours at 2200° F. (10X)



Uncoated X-40 cobalt-base alloy after oxidation for 23 hours at only 2000° F. (10X)

One of several applications of Misco-DEW diffusion coatings provides greater surface stability to various metals and alloys in high temperature environments.

For example, the oxidation during 100 hours of exposure at 1500°F. of low-carbon steel diffusion coated by our Vapor Diffusion Department is less than one percent of the attack on the uncoated metal.

Although the nickel-base and cobalt-base high temperature alloys are generally regarded to possess inherently good surface stability, up to the temperatures at which their strength properties limit more severe environmental temperature service, Misco vapor diffusion coatings on these types of parent materials significantly—

- **Improve elevated temperature oxidation resistance up to 1800°F. for nickel-base alloys and up to 2000°F.—2200°F. for cobalt-base alloys.**
- **Decrease susceptibility to the formation of cracks in cobalt-base alloys which are occasioned by thermal shock in temperature ranges rapidly varying from ambient to 2000°F.**
- **Improve mechanical fatigue properties. For example, Inco 100 nickel-base alloy diffusion coated, utilizing the Misco-DEW vapor diffusion techniques, withstood 34,000 cycles in mechanical fatigue tests at 1500°F. This represents an improvement in excess of 30% over uncoated specimens of this alloy.**
- **Decrease corrosive attack by some media, e.g., intergranular corrosion of nickel-base alloys by sulfur-bearing gases, in elevated temperature environments.**

The formation of a suitable protective alloy case by vapor diffusion is dependent upon the coating constituents, the processing parameters, and the proper selection of the parent material.

Our staff can assist you in the solution of your protective coating problems.

Misco Precision Casting Company

DIVISION OF HOWE SOUND COMPANY

MISCO

address inquiries to

VAPOR DIFFUSION DEPARTMENT

124 SIBBS STREET
WHITEHALL, MICHIGAN
Telephone TWinoaks 5-1515

For more information, turn to Reader Service card, circle No. 355

Coming Meetings

AMERICAN STANDARD ASSN., 12th national conference. Houston, Tex. Oct 10-12.

MAGNESIUM ASSN., 17th annual conference. New York City. Oct 16-18.

2ND INTERNATIONAL CONGRESS ON VACUUM TECHNOLOGY, American Vacuum Society Inc. Washington, D.C. Oct 16-19.

AMERICAN SOCIETY FOR QUALITY CONTROL, 16th midwest conference. St. Louis. Oct 19-20.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, fall meeting. Roanoke, Va. Oct 19-21.

ABRASIVE GRAIN ASSN., fall meeting. New York City. Oct 23-25.

METALLURGICAL SOCIETY, AIME, fall meeting. Detroit. Oct 23-26.

43RD METAL CONGRESS AND EXPOSITION, American Society for Metals. Detroit. Oct 23-27.

AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS, semi-annual engineering conference. Toronto. Oct 26-27.

AMERICAN NUCLEAR SOCIETY, 9th Hot Laboratory and Equipment Conference. Chicago. Nov 6-10.

STEEL FOUNDERS' SOCIETY OF AMERICA, 16th annual technical & operating conference. Cleveland. Nov 13-15.

7TH ANNUAL CONFERENCE ON MAGNETISM AND MAGNETIC MATERIALS, American Institute of Electrical Engineers. Phoenix, Ariz. Nov 13-16.

SYMPOSIUM ON CERAMICS AND COMPOSITES, COATINGS AND SOLID BODIES, Society of Aerospace Material and Process Engineers. Dayton, Ohio. Nov 14-15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, winter meeting. New York City. Nov 26-Dec 1.

28TH EXPOSITION OF CHEMICAL INDUSTRIES. New York City. Nov 27-Dec 1.

19TH ELECTRIC FURNACE CONFERENCE, Metallurgical Society, AIME. Pittsburgh. Dec 6-8.

METAL JOINING SYMPOSIUM, Pennsylvania State University. University Park, Pa. Dec 11-13.

THERMOPHYSICAL PROPERTIES SYMPOSIUM, Princeton University. Princeton, N. J. Jan 24-26.

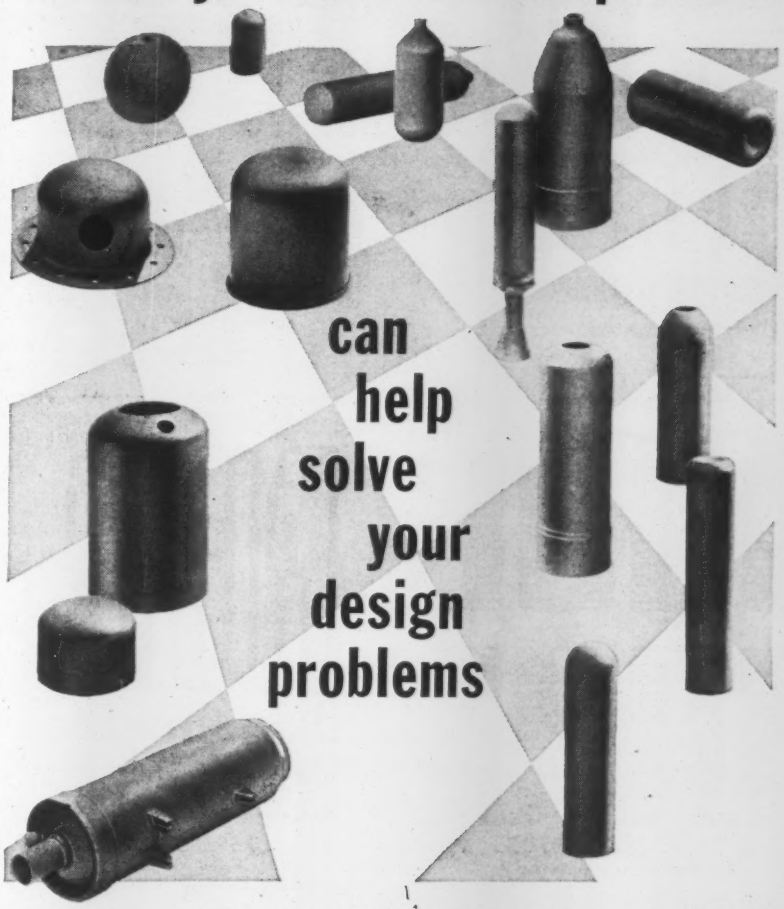
18TH ANTEC, Society of Plastics Engineers. Pittsburgh. Jan 30-Feb 2.

17TH REINFORCED PLASTICS DIV. CONFERENCE, Society of the Plastics Industry, Inc. Chicago. Feb 6-8.

GOLDEN GATE METALS CONFERENCE, San Francisco. Feb 15-17.

AMERICAN INSTITUTE OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS, annual meeting. New York City. Feb 18-22.

Hackney seamless components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solve
your
design
problems

Whatever your shape or shell problem, the solution lies in Hackney deep drawn forming methods. There are two good reasons why:

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Second, many of the sizes you need are quickly available because we have a large assortment of dies, mandrels and related tooling. And our experience and facilities are at your disposal to transform any of your design ideas into reality.

Why not let our engineers help you work out details and suggest ways to improve reliability and reduce costs. Your components can be formed in steel, magnesium, nickel, ultra-high-strength stainless steels, hot work tool steels, molybdenum or titanium. Units can be made in sizes from 1 qt. to 100 gal.; diameters range from 2″ to 32″; lengths may be from ½ to 5 times the diameter, or up to 110″. For complete information, write to the address below.

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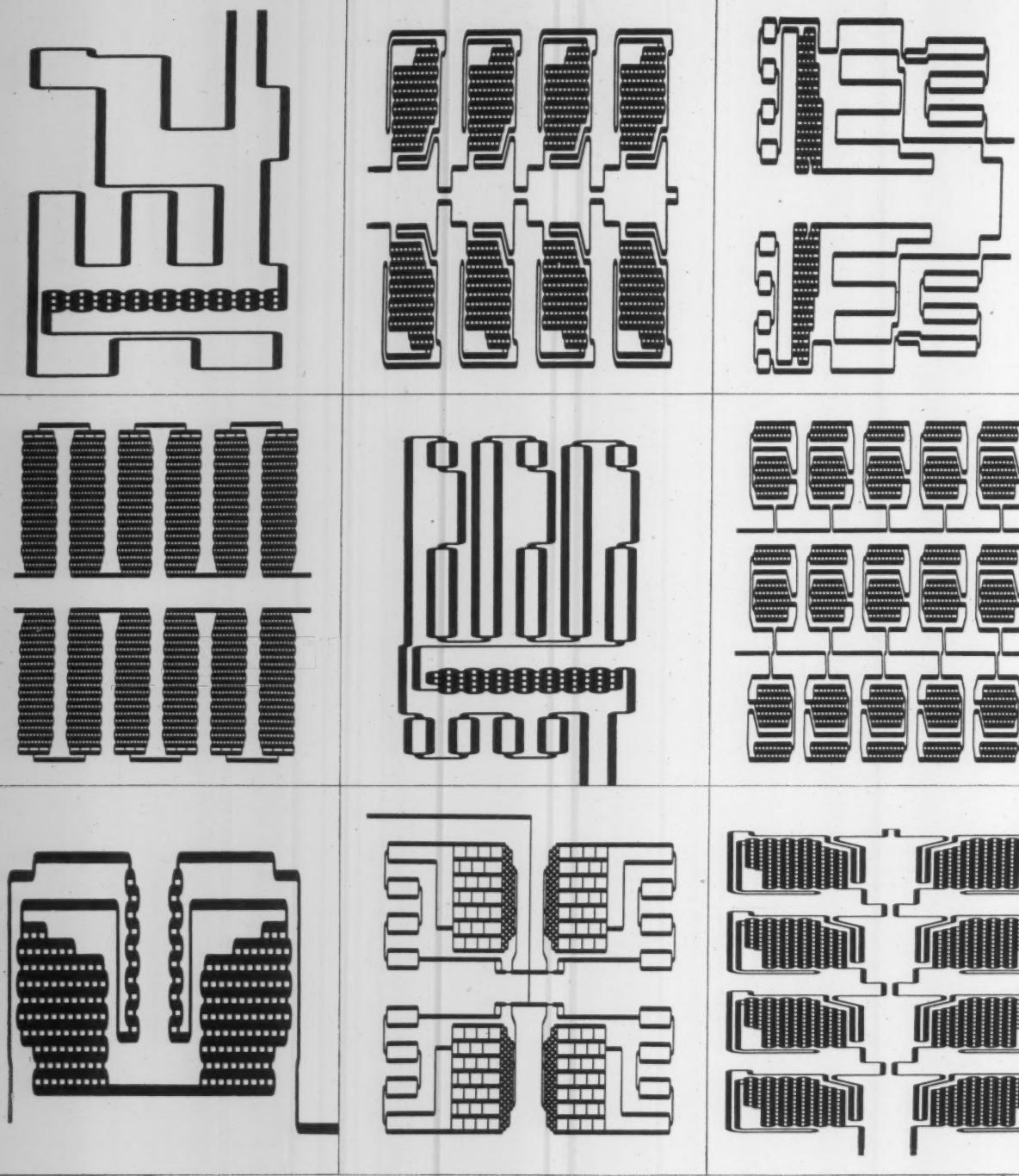

Any continuous tubing pattern you can create on paper can be put into a homogeneous aluminum or copper ROLL-BOND sheet.

For Brochure write Sales Manager, Roll-Bond Products, Olin Mathieson Chemical Corporation, East Alton, Illinois.

Olin
METALS DIVISION

For more information, turn to Reader Service card, circle No. 443

Better follow-through on research

To the Editor:

I agree with the emphasis placed by you upon the urgency and need for more engineers and scientists (M/DE, Aug '61, p 196). I also agree with the government's approach as outlined in *Scientific Progress, the Universities and the Federal Government*, issued by the President's Science Advisory Committee.

But I have yet to read or hear of any follow-through that would reasonably assure the end use of such advanced technical knowledge, especially by the government in so far as procurement is concerned.

What is the real purpose, after all, of acquiring advanced scientific facts? The only benefit most certainly must come from the actual use of such accumulated knowledge.

During the past few years, I have had the following experience in dealing with the development of highly technical material for the Bureau of Ships: after successfully meeting Government specifications (as well as surpassing most), I was told by the very office making the request that the specifications on which I qualified had been cancelled and new specifications were being written. The new specifications, in effect, are lower than the requirements I had successfully met.

This is presently being done and can be repeated in any situation where it is necessary to induce competitive bidding . . . I expect to follow this situation to a final conclusion in Washington . . .

JAY B. HINSON
Hartsdale, N. Y.

It's not quite so simple

To the Editor:

Your fine magazine is eagerly awaited and avidly read each month by many people in our company. Many articles are of lasting interest and these are clipped and filed under various headings. However, the layout of your magazine makes this very difficult because practically all articles end on the right-hand page with the next article beginning on the following left-hand page.

We realize that you are trying to provide a two-page spread for your titles; however, this too is not desirable for filing purposes, because only the first page shows up when the article is filed.

May we offer the suggestion that all articles start on the right-hand page and conclude at the left-hand page with short filler articles or with ads.

We feel sure that this change would make your magazine more valuable to your readers by providing a method of keeping articles of lasting interest.

(continued on p 27)

THIS IS

ONE USE FOR INDIUM

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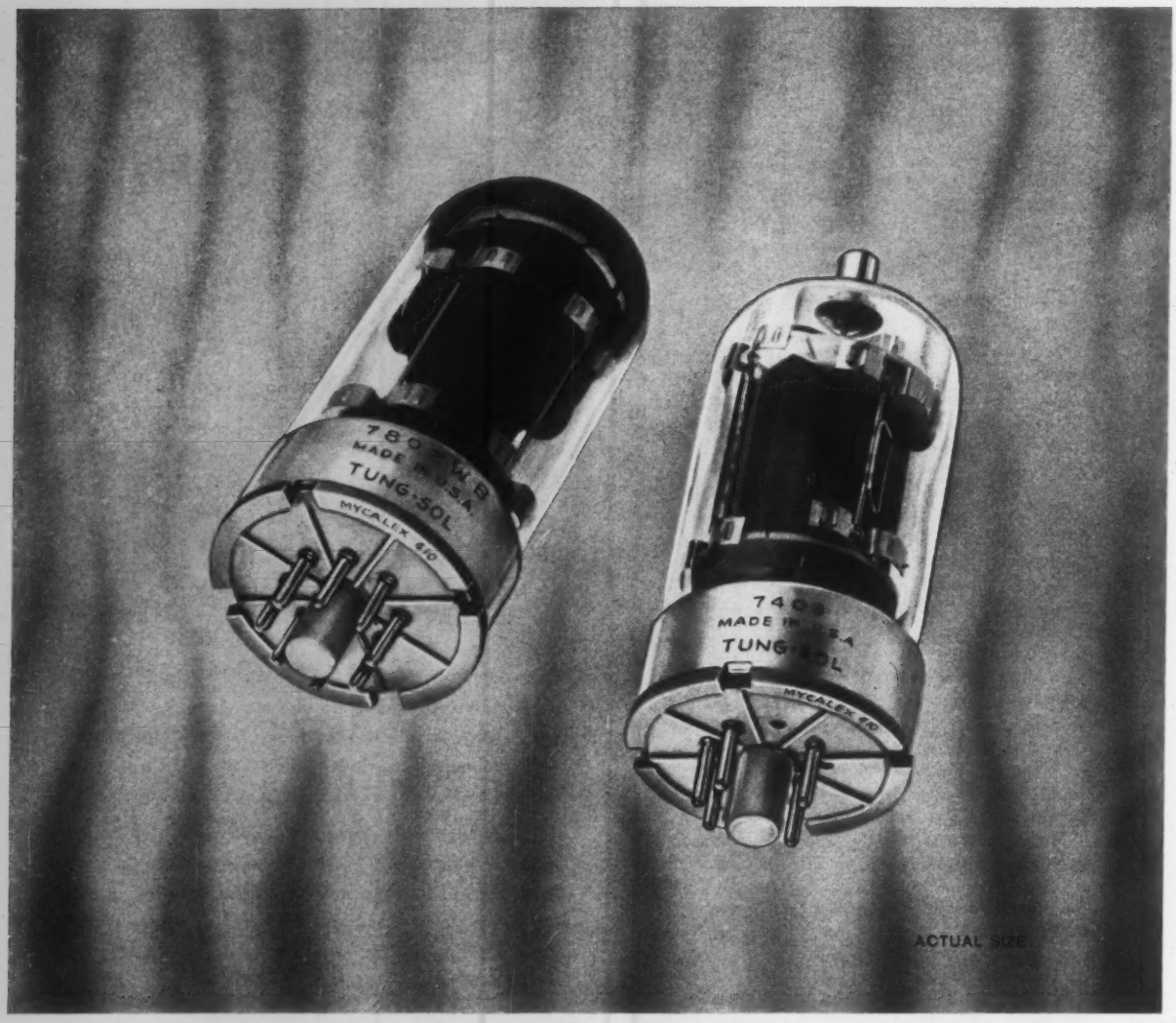
When the requirements seem impossible...



TUNG-SOL specifies MYCALEX® 410 glass-bonded mica for extraordinary reliability

THE HEAT'S ON . . . to combat close quarters in critical power supply applications resulting in bulb temperatures up to 572°F., TUNG-SOL engineers chose MYCALEX 410 glass-bonded mica for the base of their new 7802WB Series Regulator Tube. TUNG-SOL also specifies the MYCALEX 410 glass-bonded mica for its new type 7403 "hard" pulse modulator tube. This *unique* electronic insulating material . . . can be precision-molded . . . does not blister, char or develop leakage paths under difficult operating conditions. It exceeds requirements for a MIL-E-ID Qualification Zone 15 rating . . . offering a maximum temperature endurance of 650°F. (unstressed), and absolute dimensional stability.

Whatever your problem—"hot spots," reliability, intricate inserts, complex geometry—MYCALEX CORPORATION OF AMERICA has the facilities to supply a ceramoplastic or glass-bonded mica insulation material in either precision-molded or machinable grades for your application. On short or large production runs, the more exacting the specification, the more you will appreciate the unduplicated advantages of these materials. Write for design information on MYCALEX glass-bonded mica . . . SUPRAMICA® ceramoplastics offering maximum temperature endurance of 1550°F. (unstressed) and SYNTHAMICA® synthetic mica with maximum temperature endurance of 2000°F. (unstressed) . . . the family of the world's most *nearly perfect* insulation materials.

Our engineers will be glad to assist you with your design and production problems.

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World's largest manufacturer of ceramoplastics, glass-bonded mica and synthetic mica products

For more information, turn to Reader Service card, circle No. 447

You do a fine job of this in your "Special Reports," which can be removed in their entirety.

LOUIS T. KASMER
Prince Rubber & Plastics Co., Inc.
Buffalo, N. Y.

This is an oft-received suggestion. We also get an equal number of letters opposing the positioning of advertising pages in the editorial sections.

How long, not how strong

To the Editor:

There are many manuals and articles published on which glues or cements will hold what materials under what circumstances. But I have never seen a tabulation on *how long* the glue will maintain its holding power or even its identity. Many glues and cements are sold to the public and industry that simply disappear with time—often a very brief time. I fasten things with these cements and they become unfastened in a few months (sometimes only a few weeks) and I can't even tell that the glue has ever been in the joint—or else I find mere traces of brittle stuff that crumbles to powder in my fingers. These glues are often sold under the most reputable tradenames.

In contrast, my parlor chair (known to have been in the White House when John Adams was president) is still holding together perfectly. How about publishing some data on this aspect.

EDWIN L. CADY
Consultant
Montgomery, Ala.

We will certainly consider publishing data (if available) on this subject; in the meantime, perhaps our readers will have some comments.

Help needed on castable polyurethanes

To the Editor:

I am interested in any literature you might have on castable polyurethanes, including predicted amounts to be used, quantities used in the past, predicted market areas, and potential product types.

ARNOLD P. BARTH
Chemist
Chicago Rawhide Mfg. Co., Inc.
Chicago, Ill.

We have sent Mr. Barth information on where castable polyurethane elastomers are being used. However, our interest is primarily in the application *of engineering materials, and we do not have any production or marketing figures available.*

4 ULTRASONIC PROBLEM BUSTERS by BRANSON

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SONORAY detects and locates flaws. SONORAY measures thickness and detects metallurgical variations.
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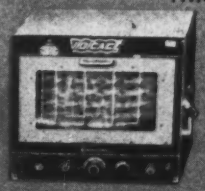

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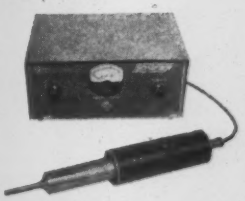
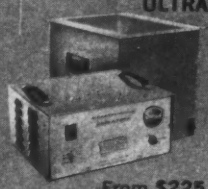


ULTRASONIC CLEANING



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STRENGTH +
LIGHT WEIGHT
That's the Beauty of Steel

17,000 pounds of N-A-XTRA steel are used in this Model PSC-375 Portable Scrap Compressor, manufactured by Harris Foundry & Machine Co., Cordele, Georgia

STRENGTH + LIGHT WEIGHT OF

N-A-XTRA

HIGH-STRENGTH STEEL SOLVES PORTABLE SCRAP COMPRESSOR PROBLEM

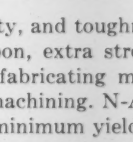
This unique portable scrap compressor can squeeze an entire auto body into a 21″ x 36″ x 24″ bale of 20% dense steel scrap, using a ram pressure of 375 tons. Designed to be hauled from job to job by a conventional truck-tractor, it goes to work in outlying wrecking yards, compressing bulky scrap into marketable bales that can be shipped economically.

Because it must be moved over the highway and meet established load limits, a pressing problem in designing the PSC-375 was weight. Mild carbon steel with the required strength would weigh too much. N-A-XTRA high-strength steel solved the problem. It fully met all strength and fabrication requirements, yet kept total unit weight within acceptable limits for portability.

Portability may not be the controlling factor in your product—but the same steel that solved this problem is the one to remember when only the strongest steel will do. Pound for pound, N-A-XTRA steels are nearly three times stronger than mild carbon steel. Rugged conditions, heavy loads and weight-saving construction—in such applications, for example, as heavy machinery and pressure vessels—are challenges that N-A-XTRA is designed to meet.

With excellent weldability, formability, and toughness even at subnormal temperatures, N-A-XTRA low carbon, extra strength alloy steels give superior results with conventional fabricating methods, including cold forming, gas cutting, shearing and machining. N-A-XTRA high-strength steels are available in four levels of minimum yield strength, from 80,000 to 110,000 psi, and in sizes ranging from ⅛″ to 1″ thick, up to 72″ wide and up to 35′ long. For further information, write Product Development, Dept. MDE-12, Great Lakes Steel Corp., Detroit 29, Michigan.

DESIGN NOTE: Model PSC-375, Portable Scrap Compressor, uses N-A-XTRA 100 (minimum yield strength, 100,000 psi) in engine and tank mounts, bed and side ribbing, arm housings and end housing. Sizes—¼″, ⅜″, ½″, ¾″ and 1″ thick. Fabrication followed standard gas cutting and welding procedures.



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Great Lakes Steel is a Division of **NATIONAL STEEL CORPORATION**

For more information, turn to Reader Service card, circle No. 340

FOAMED VINYL COMES OF AGE

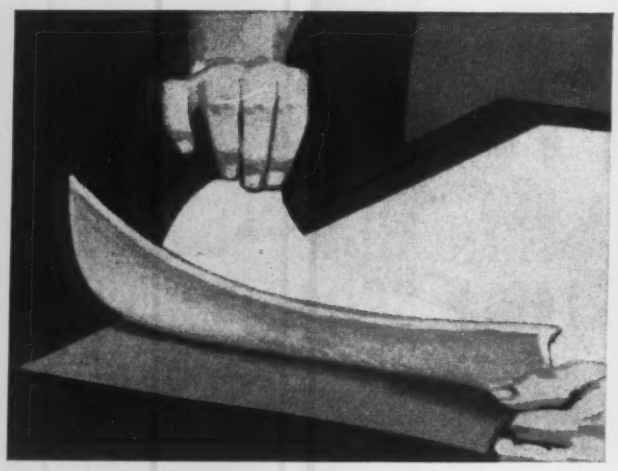
TYPICAL PRODUCTS

Suddenly foamed vinyl products are in the limelight.

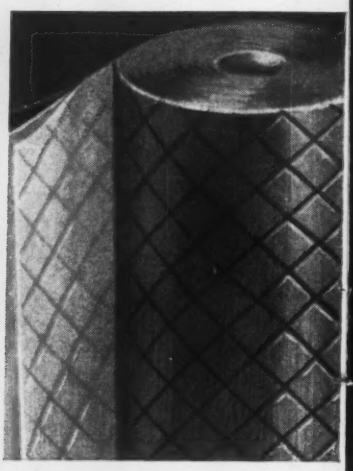
Luggage and lounges, boats and coats and floats, cars and card-tables and cushions, aircraft upholstery and athletic padding—the public has discovered and is asking for the luxury touch of this amazing material in these products and many more.

Industry, too, is on the bandwagon. Gaskets, moldings, weather stripping, wire coating and other products now take advantage of the chemical resistance, compressibility, lightness and low cost of vinyl foams.

Truly, *vinyl foams have come of age*—and now "Nitrosan", Du Pont's chemical blowing agent, enables you to use these foams with special new properties and at reasonable cost. Read the facing page for details.

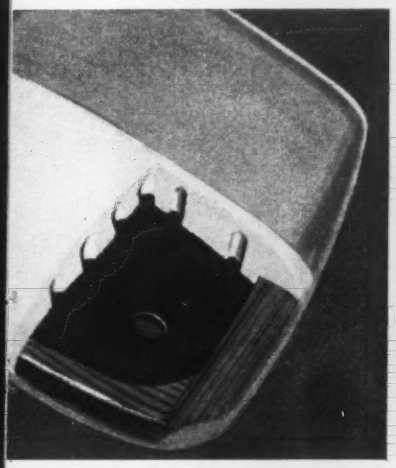


VINYL SYNTHETIC LEATHERS. Uniform gauge, sharper embossing, and the luxurious hand of open-cell foam are some of the advantages of using "Nitrosan."

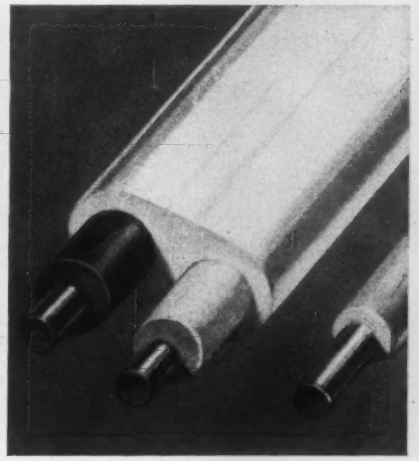


FOAMED VINYL SHEETING made with "Nitrosan" is breathable. Densities as low as 5 and 6 lb./cu. ft. open up new uses, such as embossed quilted insulation.

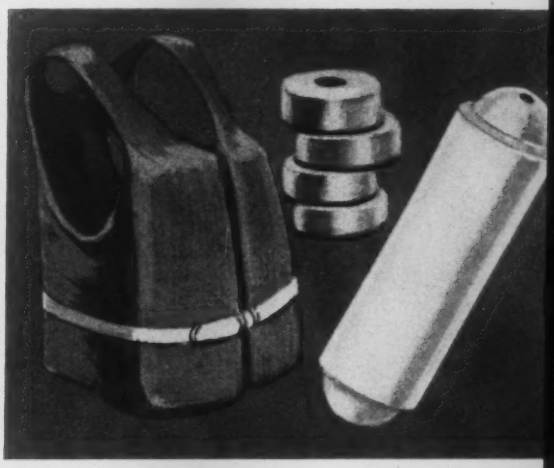
YOU CAN MAKE OR IMPROVE WITH VINYLS FOAMED BY DU PONT NITROSAN®



MOLDED VINYL FOAM
for cushions, gaskets, and other applications not only costs less to make, but thermal degradation of the resin due to the blowing agent is eliminated since "Nitrosan" functions with only a mild evolution of heat. Faster operating cycles are possible with assured quality.



WIRE INSULATION
can be extruded at nearly twice the speed permitted by blowing agents that decompose above the gelation temperature of the vinyl. Further, foaming reduces resin requirements by 50%, and produces light weight insulation while improving electrical properties.



FLOTATION EQUIPMENT
can be molded under pressure, producing a closed-cell structure with all the usual advantages of "Nitrosan": low foaming temperatures, low exotherm, easy handling, fast operation and low cost of production equipment.

Now, Du Pont **NITROSAN®** *makes vinyl foams more practical, useful and versatile than ever before*

Change your mind about vinyl foams. They *were* limited in usefulness, and they *did* require a huge investment in manufacturing equipment.

But no longer.

Du Pont's "Nitrosan" blowing agent has turned PVC foam into a practical, useful and versatile material that merits the attention of every designer.

Foams can now cost less because "Nitrosan" operates at relatively low temperatures, eliminating much expensive equipment.

And it adds many new properties to vinyl's bag of tricks.

MAKES BETTER, LIGHTER, EASIER-TO-EMBOSS FOAMS

Because it foams the vinyl *before* gelation, "Nitrosan" gives these new and distinctive advantages:

Densities can be as low as 5 or 6 pounds per cubic foot—opening up possibilities for new products you couldn't consider in the past.

Cell structure can be either open or closed type. Most commonly, "Nitrosan" is used to produce the open type, because the resultant interconnected fine cells give a more luxurious hand to the product.

Sharper embossing patterns can be made, as a result of the lower density and the fine open-cell structure of vinyls foamed with "Nitrosan".

WRITE FOR FACTS, SAMPLES

Your materials library is not complete without something on foamed vinyls. Let us help you fill that gap. For additional information or a sample of "Nitrosan"-foamed vinyl, write on your company letterhead to Chemical Products Sales Div., Explosives Dept., Du Pont, 6539 Nemours Bldg., Wilmington 98, Del. Or contact any of these district sales offices:

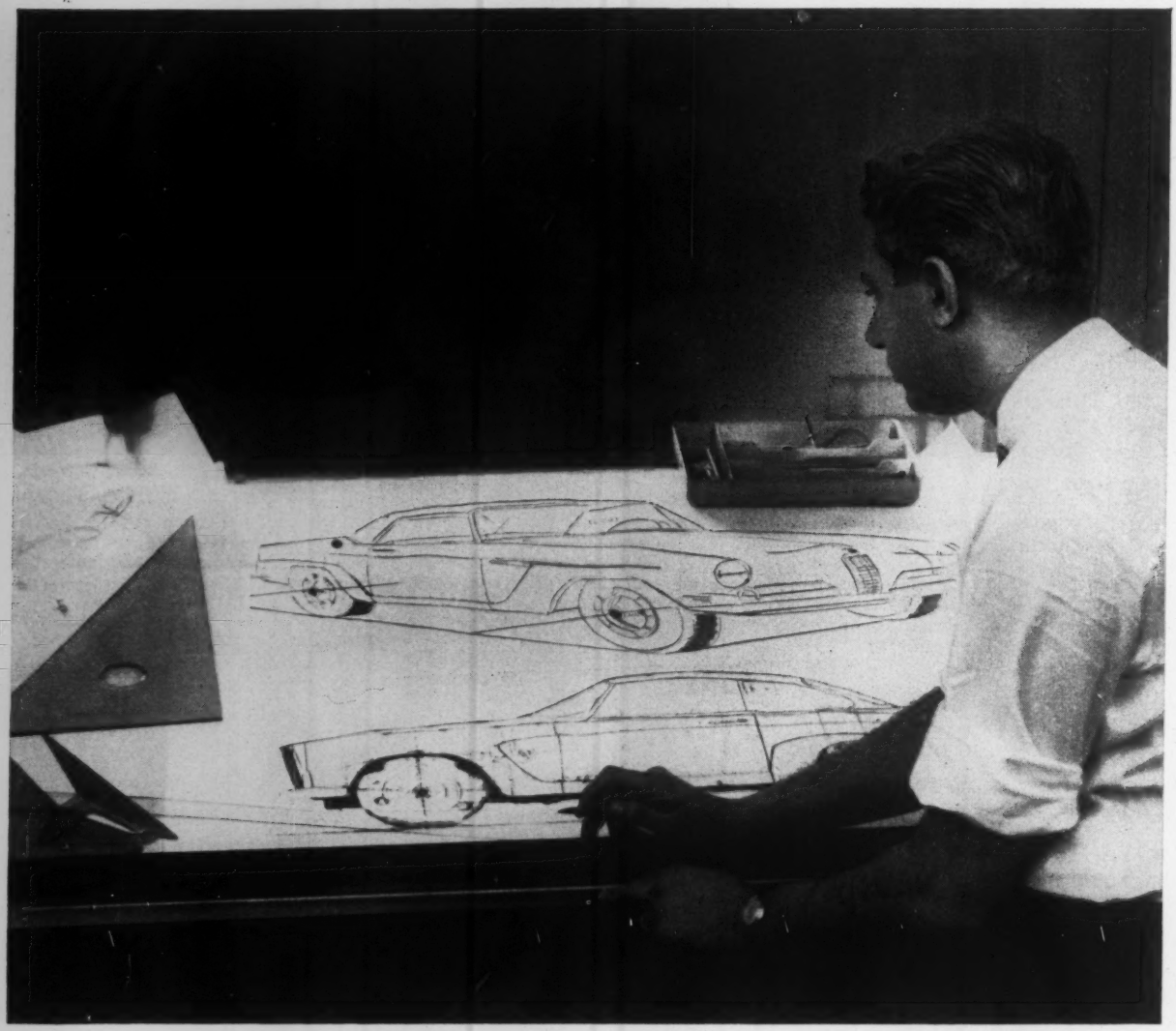
BOSTON: 140 FEDERAL ST., HA 6-1724 / **CHARLOTTE**: 427 W. FOURTH ST., FR 5-5561 / **CHICAGO**: 7250 N. CICERO AVE., LINCOLNWOOD, OR 5-1010 (FROM CHICAGO, IN 3-7250) / **CLEVELAND**: 11900 SHAKER BLVD., LO 1-5070 / **HOUSTON**: P.O. BOX 22207, MO 7-9197 / **LOS ANGELES**: 2930 EAST 44TH ST., LU 2-6464 / **NEW YORK**: 4700 EMPIRE STATE BLDG., LO 3-6400.

DU PONT NITROSAN®
REG. U.S. PAT. OFF.
blowing agent

Better Things for Better Living... *through Chemistry*

For more information, turn to Reader Service card, circle No. 428

WHAT'S NEWS IN RUBBER



In design after design...the big switch is to BUTYL!

Automotive engineers have discovered that Enjay Butyl rubber is one of the best ways to improve car performance. Now all U.S. cars contain parts made from Enjay Butyl . . . parts such as weatherstripping, body mounts, engine mounts, radiator hose, accelerator pedals, and many more. Engineers specify Enjay Butyl rubber because...

- *Butyl resists weathering*
- *Butyl deadens noise and vibration*
- *Butyl absorbs shock*
- *Butyl beats the heat*
- *Butyl resists tear, flex and abrasion*

Enjay is always ready to help manufacturers build the extra performance of Butyl into their cars. For more information, contact Enjay's Detroit Area Office, 17360 West Eight Mile Road, Southfield, Mich. Phone KEnwood 2-7113.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY® BUTYL

For more information, turn to Reader Service card, circle No. 364

For more information, circle No. 412 ➤

working with

Du Pont Zytel®

one of Du Pont's versatile engineering materials

Fuel regulator molded of ZYTEL® NYLON RESINS

is lower in cost, lighter in weight, easier to install

You might well ask, "lower", "lighter" and "easier" than *what?* The answer: *than automotive fuel-pressure regulators constructed of metal or glass and metal.* This new fuel regulator, which controls the pressure of gasoline injected into the carburetor, has three major parts precision-molded of Du Pont ZYTEL nylon resin . . . eliminating the expensive machining and finishing operations usually associated with metal regulators. Hence, cost is lower. Molded in ZYTEL, the regulator weighs only 2 oz., eliminating the need for metal clamps or other fittings. The new unit installs without adaptors to any gas line by inserting ends of the opened line into bushings pressed into the unit.

Key to the selection of ZYTEL for this exacting application is the combination of properties offered by these resins: high mechanical strength and resistance to gasoline and petroleum products at high engine temperatures.

The Miser-Mite fuel-pressure regulator is molded by Artag Plastics Corp., Chicago, Ill., for Milemaster, Inc., Exeland, Wisconsin.

On the next page you will find more examples of how the properties of ZYTEL nylon resins are being used to improve the design and performance of products in a variety of fields.

DU PONT

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BETTER THINGS FOR BETTER LIVING

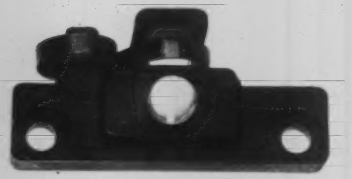
...THROUGH CHEMISTRY

working with

Du Pont Zytel®

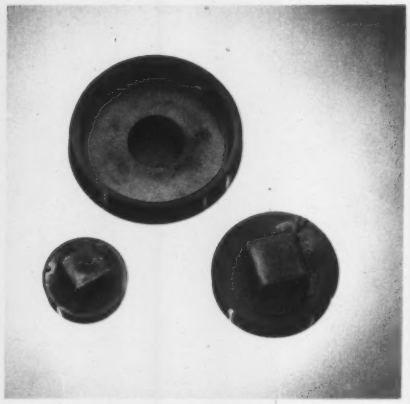
nylon resins

one of Du Pont's versatile engineering materials



Electric motor brush holder used in an improved electric impact wrench is a one-piece molded part of ZYTEL, providing excellent electrical insulation properties, wear resistance and high strength. Cost, including parts and assembly time, is 65% less than the three-piece fabricated brush holder assembly previously used. Molded by Amos-Burke Plastics, Inc., Syracuse, N. Y., for Chicago Pneumatic Tool Company, Utica, N. Y.

Swivel chair hub liner molded of ZYTEL® eliminates necessity of lubricating center spindles, maintains a wobble-free, tight fit through long periods of use. ZYTEL nylon resin was selected for its low coefficient of friction, resistance to impact and abrasion, and close molding tolerances. Molded by Nylon Products Corp., affiliated with F. J. Kirk Molding Co., Clinton, Mass., for Collier-Keyworth Company, Gardner, Mass.



Removable cleanout plug allows cleaning of sewage drainpipes. Molded of ZYTEL, the plug can be removed easily time after time, does not stick—because ZYTEL nylon resin resists the accumulation of mineral deposits from water. Quick, accurate injection molding eliminates need for sand casting and thread machining required by brass plugs. Coast Craft Industries, Glendale, California, for A. H. Voss Co., Los Angeles, California.

Three useful properties of ZYTEL® NYLON RESINS: high insulation . . . low friction . . . good moldability

Depending on the particular application, different combinations of properties offered by ZYTEL nylon resins become crucial—as witness the applications discussed on this page and the preceding page. To evaluate the design opportunities offered by ZYTEL for your application, consider the entire range of properties offered by ZYTEL nylon resins, and the many different formulations of ZYTEL available. The coupon below will bring you pertinent further information.

POLYCHEMICALS DEPARTMENT

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

E. I. du Pont de Nemours & Co. (Inc.), Dept. 4
Room 2507Z, Nemours Building, Wilmington 98, Delaware.
Please send me: ☐ How 50 Manufacturers Used ZYTEL® Nylon Resins to Make Better Products
☐ Designing with ZYTEL®
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Name_____ Position_____
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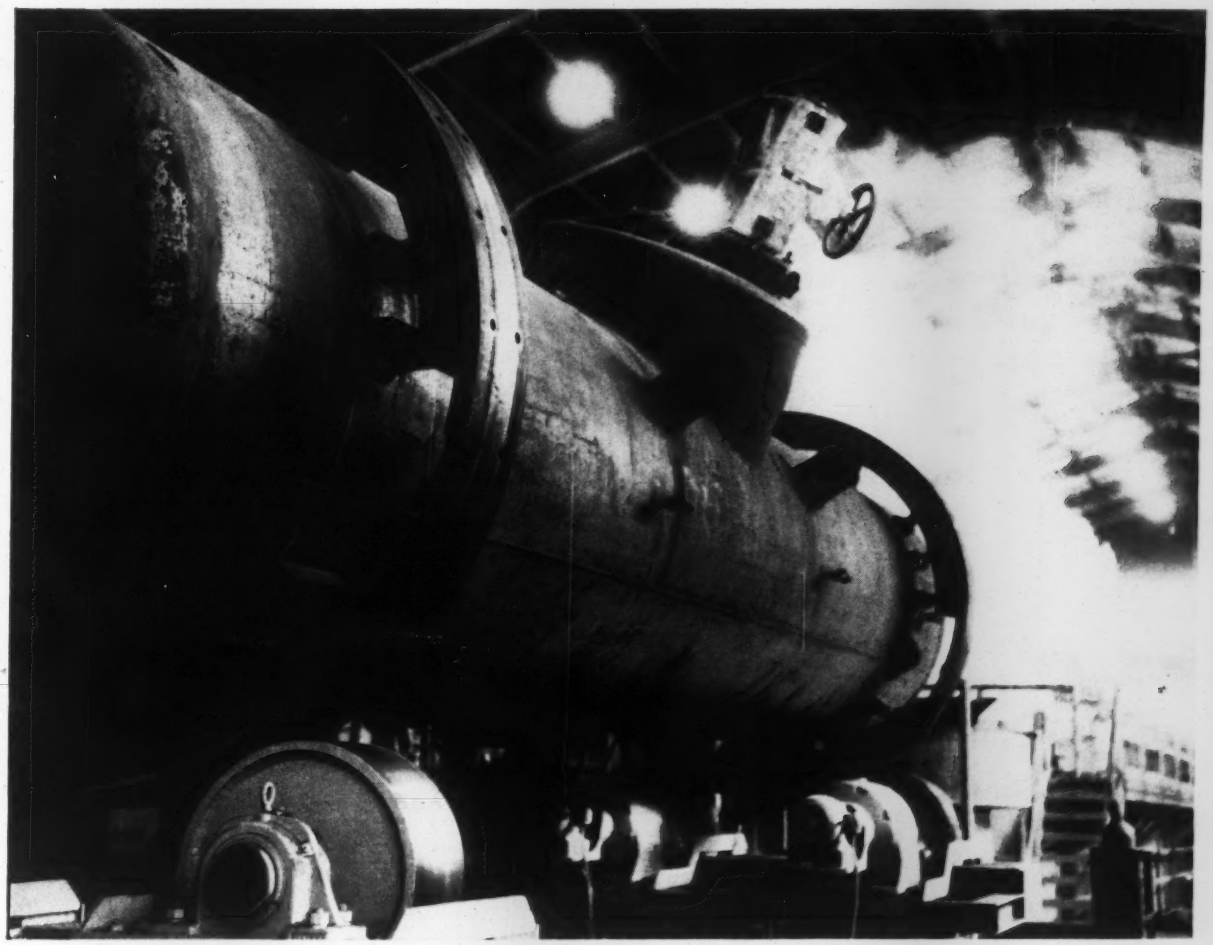
A

ZYTEL® *nylon resins*

one of Du Pont's versatile engineering materials

Alathon® · Delrin® · Lucite®



IF YOU CAN SHIP IT WE CAN PLATE IT!

NO MATTER WHAT THE SIZE OR SHAPE OF YOUR PRODUCT, IT CAN BE COATED BETTER WITH KANIGEN® NICKEL ALLOY

The specialists at General American's Kanigen plant in Sharon, Pennsylvania can deposit an even coating of hard nickel alloy on most ferrous metals in common use. Regardless of how high, wide or heavy the object is, if you can get it to Sharon, we can plate its interior.

Before General American developed Kanigen coating, it was next to impossible to deposit an even nickel plating over very large surfaces or on many complex shapes. Since Kanigen nickel plating is purely a chemical process involving no electric current, it works equally well on simple or complex shapes and on small or large surfaces. Thickness uniformity of the coating is independent of part complexity or size.

Only General American and its authorized licensees around the world can show you how Kanigen coating may improve your product. The Kanigen process is protected by more than 30 separate patents. For detailed technical literature, write for bulletin No. 561.

Kanigen Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street, Chicago 3, Illinois

KANIGEN GENERAL AMERICAN TRADE MARK

Offices in principal cities

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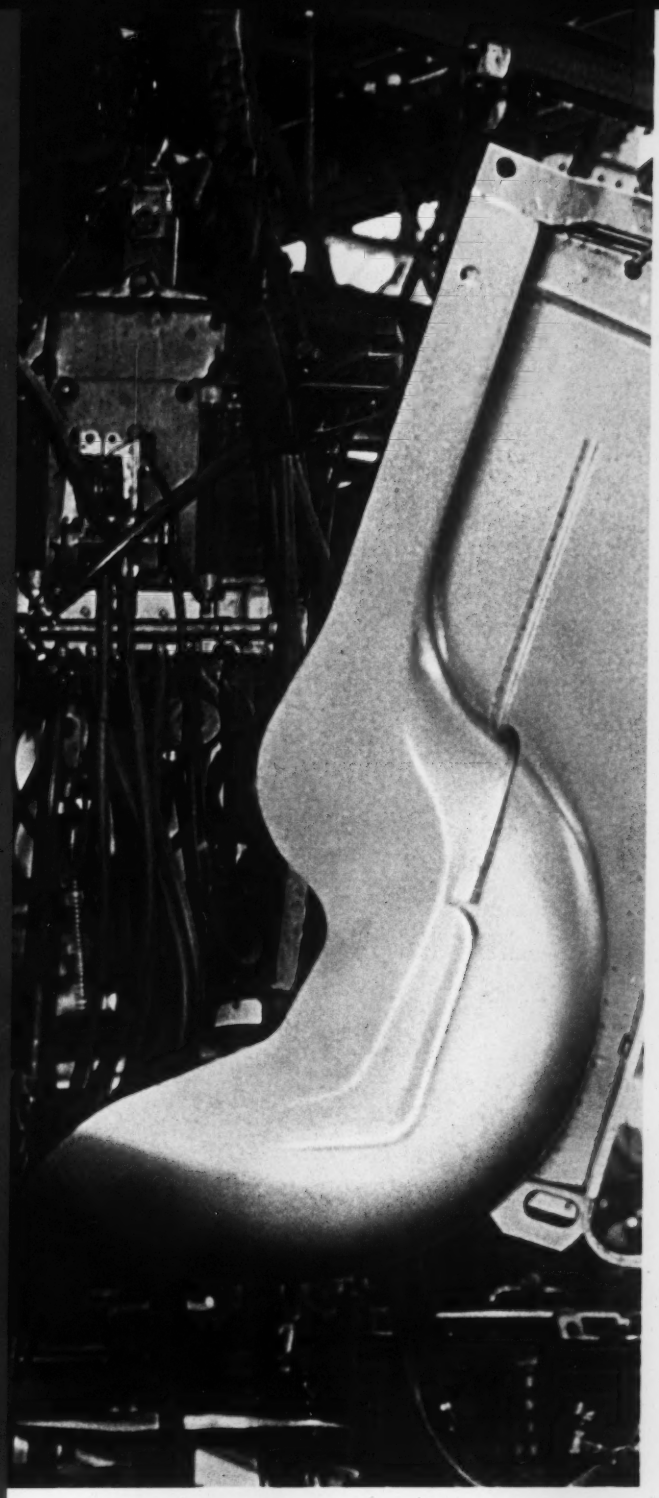


DRAW

New Youngstown rolling and annealing capacity means ready availability of higher quality sheet steel

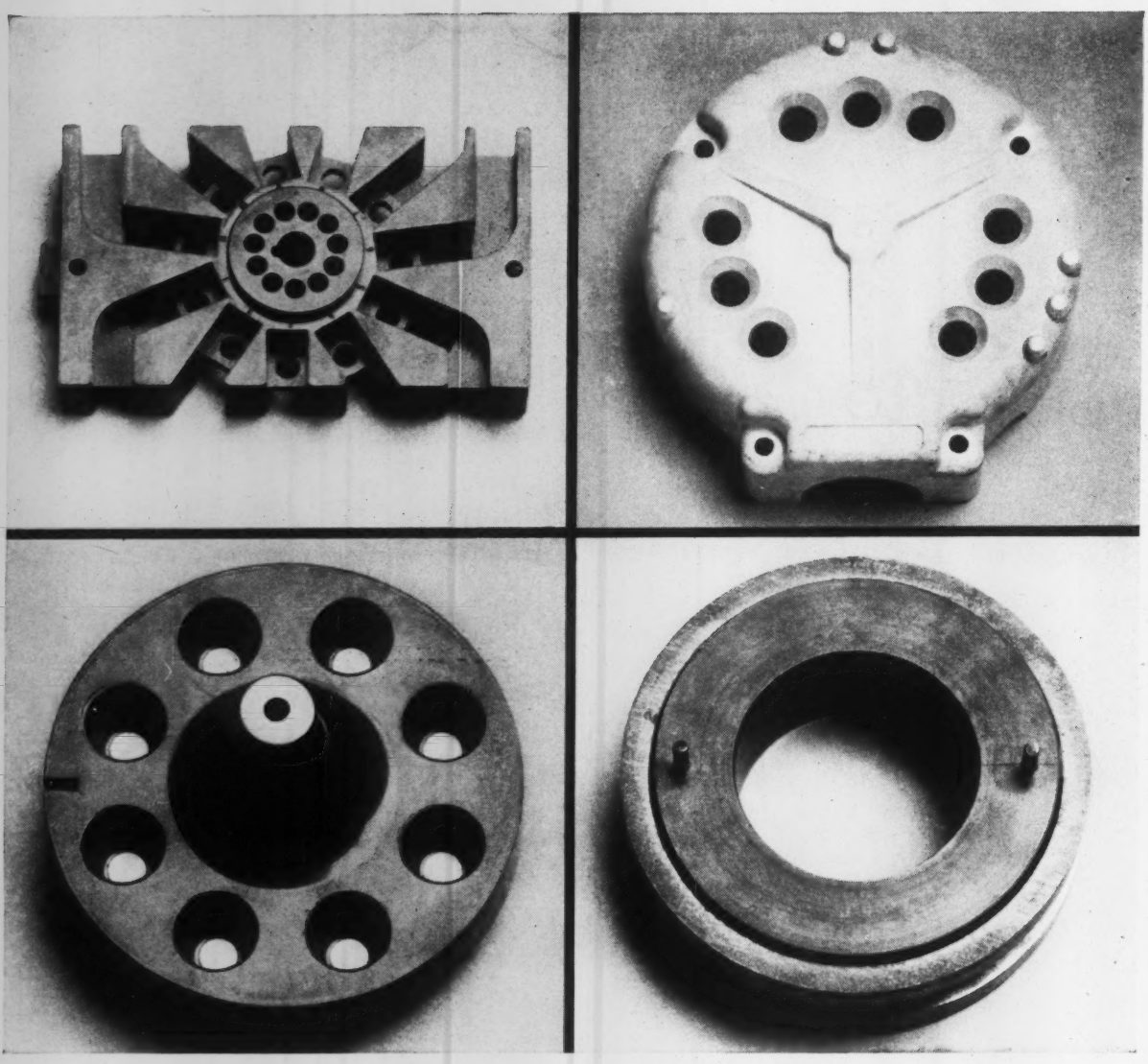
New sheet steel from Youngstown thrives in an atmosphere all its own. In 50 new stack annealing furnaces, Youngstown sheet takes on the exact grain structure and degree of plasticity you need for forming. You get the precise working characteristics required for mild or deep drawing quality.

Quality control in annealing is only a part of Youngstown's sheet story. A modernized 79″ hot strip mill with electronic testing devices and automatic gauge control equipment assures you of more uniform quality steel sheet. This giant mill rolls huge 38,000 pound coils, delivers fewer welds, reduces your coil "down time." Prior to annealing, cold tandem mills reduce thickness to strict tolerances and give the sheet its exacting finish.

Order new Youngstown sheet in widths from 24″ to 72″. Use it in mild and deep draws. Work with it. You'll find it delivers all the qualities you need. Specify Youngstown sheet from 28 Youngstown District Offices or from your nearby Steel Service Center. Specify Youngstown's new annealing process. Specify softness. Or tempered hardness. You can depend on getting precisely what you want, when you choose Youngstown sheet.

Youngstown – growing force in steel

For full details on Youngstown sheet and annealing write: Dept. 11-D,
The Youngstown Sheet and Tube Company, Youngstown, Ohio



All things considered, CYMEL® MELAMINE is the plastic to consider.

Consider basic properties of Cymel melamine plastic: Hardest surface of any plastic yet developed • best wear resistance • high impact resistance • outstanding electrical properties under adverse conditions • extraordinary flame resistance • good dimensional stability • resistance to heat, boiling water and attack by solvents. ■ **Consider applications:** Cymel **592** (asbestos filled) for auto and aircraft ignition parts, radio, television and other electronic equipment components, circuit breakers, terminal blocks, switch gears. Cymel **1500** (wood flour filled) and Cymel **1502** (alpha cellulose filled) for auto ignition parts, connector plugs, industrial housings, meter blocks, wiring devices, switch gear housings. Cymel **3135** and **3136** (glass fiber filled) for heavy duty naval, military and industrial switch gears, electrical and electronic components, coil forms, terminal strips, stand-off insulators. Cymel **3020** (fabric filled) for terminal strips and circuit breakers. ■ Consider the fact that other Cymel molding compounds are available for applications where beauty and color are essential. For complete information and technical assistance, contact your nearest Cyanamid office listed below.

AMERICAN CYANAMID COMPANY CYANAMID **PLASTICS AND RESINS DIVISION**

Wallingford, Connecticut. Offices in: Boston • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Detroit • Los Angeles • Minneapolis New York • Oakland • Philadelphia • St. Louis • Seattle. *In Canada:* CYANAMID OF CANADA LIMITED, Montreal • Toronto

For more information, circle No. 413

For more information, turn to Reader Service card, circle No. 344

Bridgeport's new name for 5 billion feet— and 15 years' experience—in coated aluminum

FLEX-COLOR® is the new "shorthand" for coated aluminum sheet that does its job so well that billions of feet have been converted into product performance and satisfaction. This is the coated sheet pioneered in 1946 by Bridgeport's Hunter Douglas Division, and improved every year since by the comparative testing of every new coating for every type of performance.

FLEX-COLOR combines the dependability of performance-tested coatings with aluminum alloys specially rolled in Bridgeport mills to the highest standards of quality.

FLEX-COLOR encompasses a remarkably diverse experience in coatings systems that lets Bridgeport help you select the alloy and coating that suits your production requirements and product performance.

FLEX-COLOR is the all-the-way service that starts with product planning. Call your nearest Bridgeport Sales Office.

BRIDGEPORT FLEX-COLOR ALUMINUM SHEET

- all colors, including metallics
- all finishes from enamel to matte
- single or double-coated
- colors on one or both sides
- solid colors and 2-color patterns
- long-length rolls to 20,000 ft.

. . . all coated on aluminum specially rolled by Bridgeport to exacting gage and width specifications.
Write for samples of specific finishes in Bridgeport FLEX-COLOR aluminum.

Bridgeport Brass Company,
Bridgeport 2, Connecticut

BRIDGEPORT FLEX-COLOR ALUMINUM

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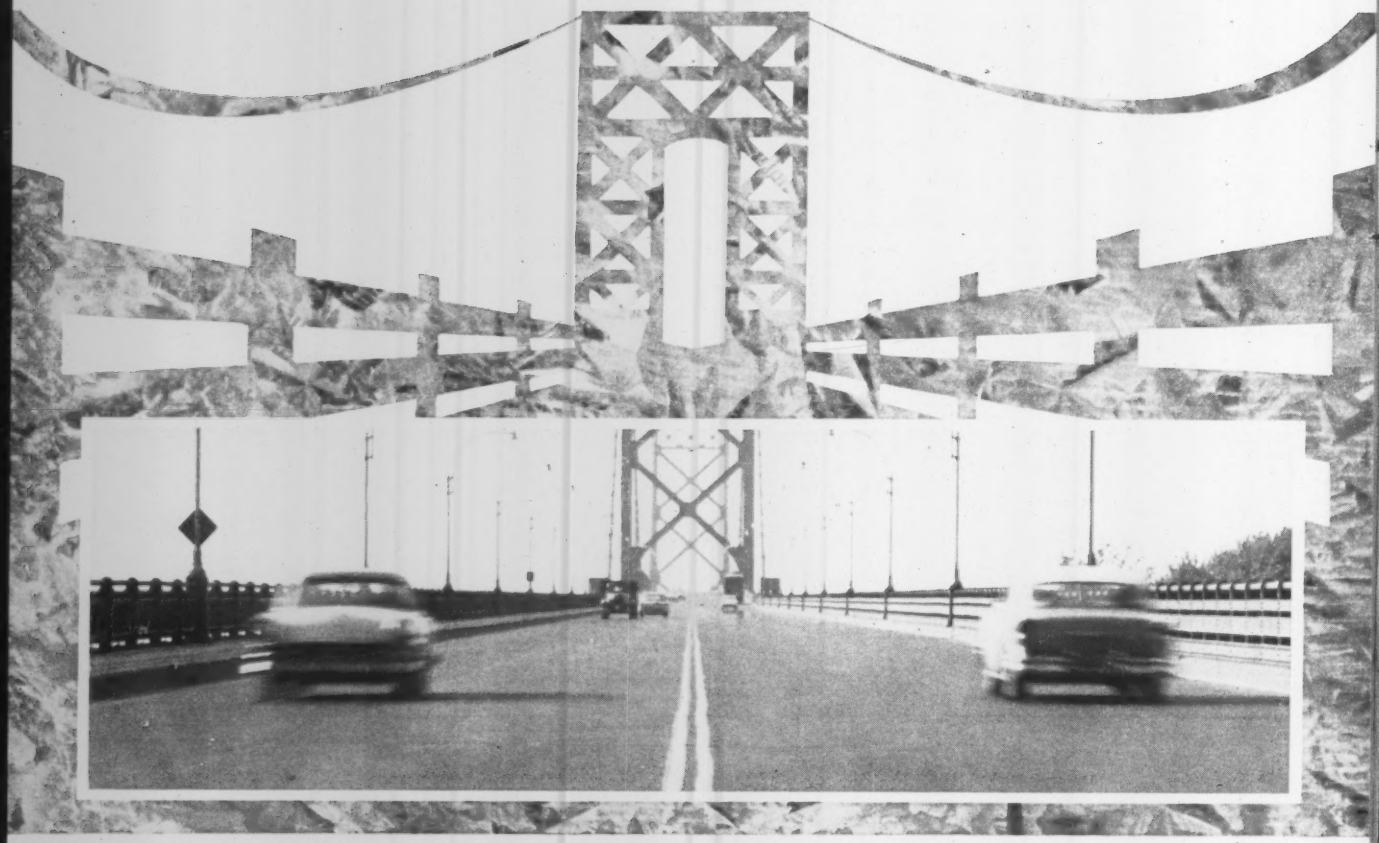
Now, the strongest bridges are the fastest to build because they're . . .



GUARDED BY GALVANIZED STEEL

Galvanized steel sheeting—long used for permanent concrete forms in building construction—has now been adapted to do the same job for bridge engineers and with remarkable success.

On bridges and their approaches, a heavier gauge sheet is used with deepened corrugations for added strength. This new form assembly is not only strong enough to support heavy concrete slabs, but installation takes only half the time required by other types of form work.

The strength and excellent corrosion resistance of galvanized steel is also winning increasing acceptance in a wide variety of architectural uses as well as in other areas of highway construction, such as culverts and guard rails.

WEIRKOTE® IN PARTICULAR is one galvanized steel that's especially well suited to all these applications. Made by the modern continuous process, it can be worked to the very limits of its steel base without losing even a chip of its zinc protection. Weirkote is made by two National Steel divisions: Weirton Steel and Midwest Steel. For further details, write to Weirton Steel Company, Weirton, West Virginia.

MIDWEST STEEL
Portage, Indiana

WEIRTON STEEL
Weirton, West Virginia

Divisions of
NATIONAL STEEL CORPORATION

For more information, turn to Reader Service card, circle No. 320

For more information, circle No. 414

Plaques of tough Butyrate plastic give super-service at gas pumps

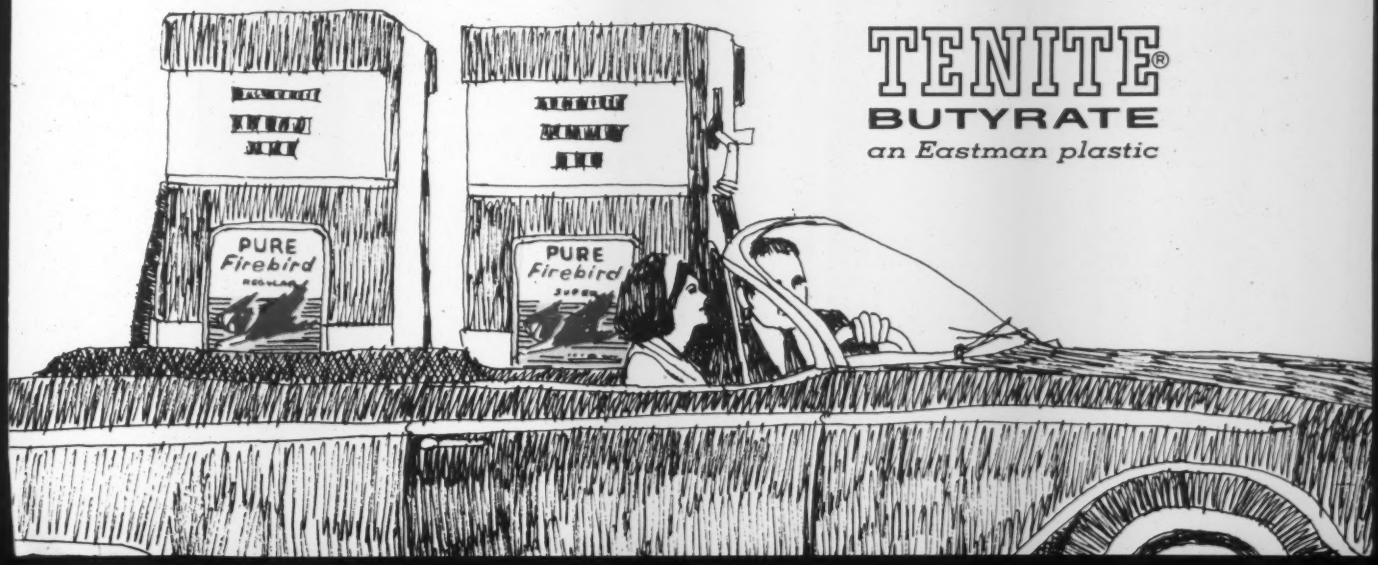
Toughness, weatherability, and eye-appeal are some of the reasons The Pure Oil Company chose sheet of Tenite Butyrate for these three-dimensional plaques. Mounted on 72,000 service station pumps, they build recognition for the new "Firebird" brand of gasoline.

And they'll stay bright and new-looking. The plastic sheet is extruded of a special outdoor formulation of Tenite Butyrate that endures weather and temperature changes, sunlight, wind, rain, snow, and hail, along with gasoline, oil, and air-borne dirt and grime. The inherent toughness and resilience of Butyrate sheet minimize breakage during manufacture, shipment, and installation, and throughout a long service life.

In producing the plaques, economies resulted from silk-screening the colors in distortion on the reverse side of clear-transparent Butyrate sheets. Subsequent vacuum-forming produced the three-dimensional plaques with striking legibility and excellent registration of the color patterns. The decoration is protected by the thickness of the clear Butyrate sheet and enhanced by its surface gloss.

If sheet of tough Tenite Butyrate plastic, in clear-transparent or tested outdoor colors, suggests ideas for improving your product, get more information and a list of suppliers from EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

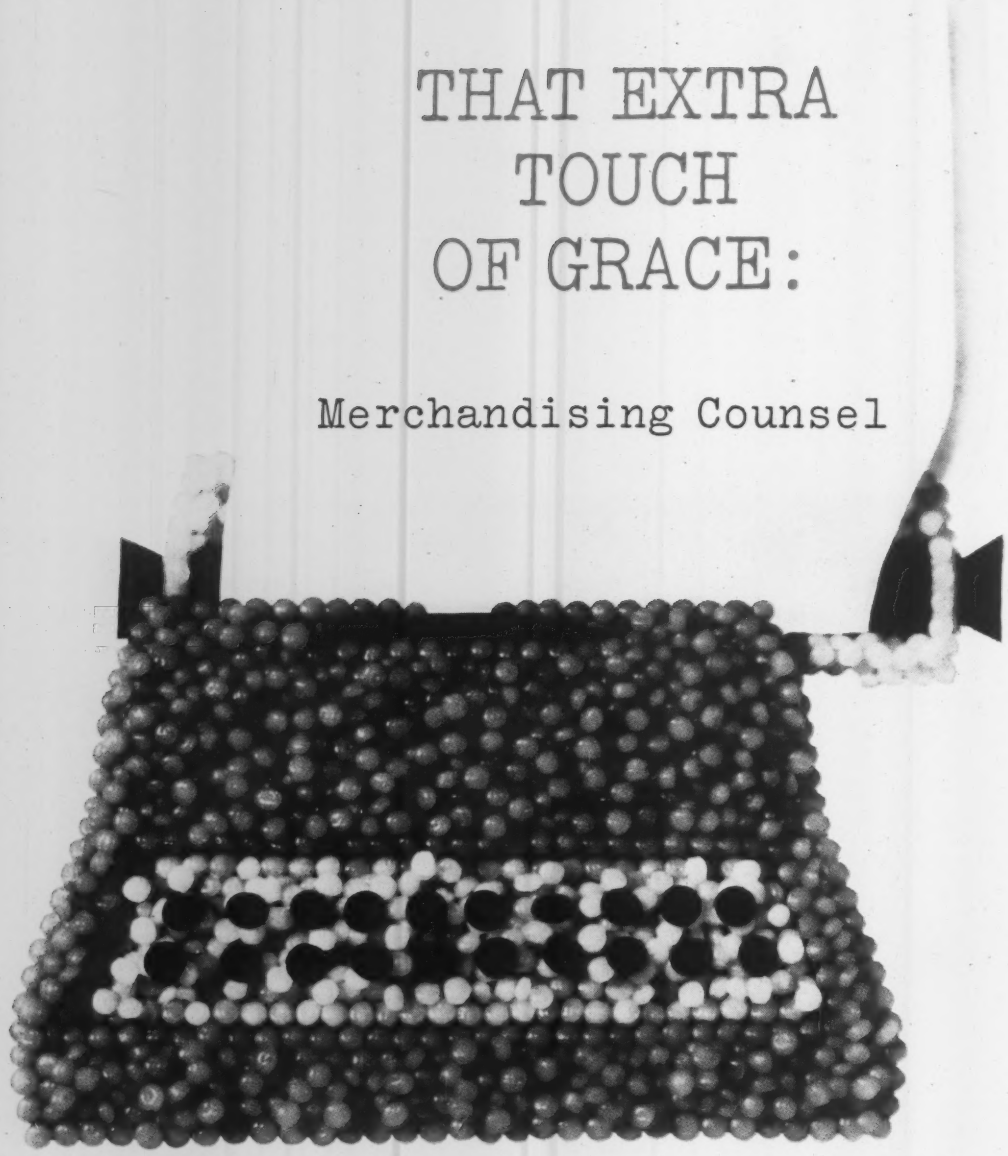
Plaques vacuum-formed by Dualite Products, Inc., Cincinnati 27, Ohio, from sheet of Tenite Butyrate extruded by General Plastics Corp., Marion, Indiana.



TENITE®
BUTYRATE
an Eastman plastic

THAT EXTRA TOUCH OF GRACE:

Merchandising Counsel



Every day retailers, distributors and consumers are literally deluged with product impressions and appeals to buy. How do you stand out from the crowd? As part of the Grace Service Plan, Grace merchandising experts can recommend appropriate programs in advertising, point of sale, display, publicity—any area where increased communications can mean increased sales. Your Grace representative can give you details of that extra touch of Grace in merchandising.

W. R. GRACE & CO. POLYMER CHEMICALS DIVISION, CLIFTON, N. J.

GREX® POLYETHYLENES · GRACE POLYSTYRENES · MOPLEN* POLYPROPYLENES · *MONTECATINI TRADEMARK

GRACE PLASTICS

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Cold stretching makes stronger steel tanks	10	602
Refractory metal developments	142	607
Weldable stainless steel	151	616
Steel for mufflers	158	622
PLASTICS		
Epoxy encapsulating resin	10	601
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Lead in the Ceramics Industries. Lead Industries Assn., 48 pp, illus. Properties and uses of lead compounds in glass, glaze compositions,

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TECHNICAL LITERATURE

(cont'd from p 49)

Books

Manufacturing Processes and Materials for Engineers. *Lawrence E. Doyle, Joe L. Morris, James L. Leach and George F. Schrader. Prentice-Hall, Inc., New Jersey. 1961. 6 by 9¼ in., 797 pp. Price $15*

According to the authors, the purpose of this book is ". . . to explain the principles upon which manufacturing processes are based and to describe practices to illustrate those principles." The authors' approach is to look upon today's diversified manufacturing processes as challenging engineering problems and to show how they can be effectively solved by the application of scientific and economic principles.

To accomplish this, the book necessarily deals with certain fundamentals; the early chapters, for example, are in the form of a review of basic metallurgical knowledge (which also serve as a good introduction to those not trained in this direction). The rest of the book is devoted to detailed discussions of manufacturing processes and forming techniques.

Specific subjects covered are: fundamentals of metals and alloys; testing of engineering materials; extraction and development of ferrous and nonferrous metals; heat treatment of steels; alloy steels and iron; nonferrous metals and alloys; foundry processes; hard mold casting processes; powder metallurgy; plastics and rubber; primary metal working processes; metal shearing and forming; welding and allied processes; measurement and inspection; economics of metal cutting; turning; automatic turning machines; economics of process planning; principles of machine tool design; drilling; shaping and planning; milling; broaching; boring operations and machines; sawing and filing; abrasives, grinding wheels and grinding operations; grinding machines and methods; surface finishing and cleaning; electrical and mechanical operations; screw threads and their manufacture; gears and gear manufacture; and automation.

Filament Winding Symposium. *Society of Aerospace Material & Process Engineers, Calif. 1961. Paper, 8½ by 11 in., 411 pp. Price $7.50*

This compilation of papers delivered at a recent SAMPE Conference on filament winding may ultimately come to be recognized as a standard reference text on the subject. The book covers practically every important aspect of this relatively new field, including applications, design, filaments, engineering, manufacturing techniques, matrixes, reliability, and the state of the art.

Some papers of particular interest include: Designing with Filament Winding; Properties of Glass Fibers at Elevated Temperatures; Review of Various Glass Filaments; Materials and Process Engineering—The Present and Future; Recent Developments in Winding Techniques; High Temperature Resin Systems; Test Methods; and Materials Research.

Progress in Semiconductors, Vol. 5. *Edited by A. F. Gibson, F. A. Kroger, and R. E. Burgess. John Wiley & Sons, Inc, New York. 1960. Cloth, 6 by 9 in., 318 pp. Price $11*

Volume 5 of this annual series covers the most significant developments in semiconductor progress during the past year. Specific subjects treated include electrical properties of semiconductor surfaces, absorption edge spectrum of semiconductors, chemical bonds, thermal conductivity, indium antimonide, magneto-optical phenomena in semiconductors, and the band structure and electronic properties of graphite crystals.

Plastics in Nuclear Engineering. *James O. Turner. Reinhold Publishing Corp., New York. 1961. Cloth, 5 by 7½ in., 139 pp. Price $5.50*

This book, the 20th in Reinhold's "Plastics Applications Series," covers the use of plastics in nuclear science and technology. It discusses such things as measurements of radiation, radiation protection, high and low voltage service, magnets, high vacuum apparatus, the effects of radiation, and optical, mechanical, thermal and miscellaneous uses.

Theory of Metal Cutting. *Paul H. Black. McGraw-Hill Book Co., New York. 1961. Cloth, 6 by 9¼ in., 204 pp. Price $7.50*

This book presents a scientific analysis of metal cutting mechanisms. The treatment is fundamental and attempts to provide a basis for efficient specification of machining operations and schedules.

Mechanical Polishing. *W. Burkart, H. Silman and C. R. Draper. Robert Draper, Ltd., Teddington. Middlesex, England. 1960. Cloth, 267 pp. Price $9*

Presents a detailed account of grinding and polishing as currently practiced in England, America and Germany. Covers processes, materials and theory for ferrous and

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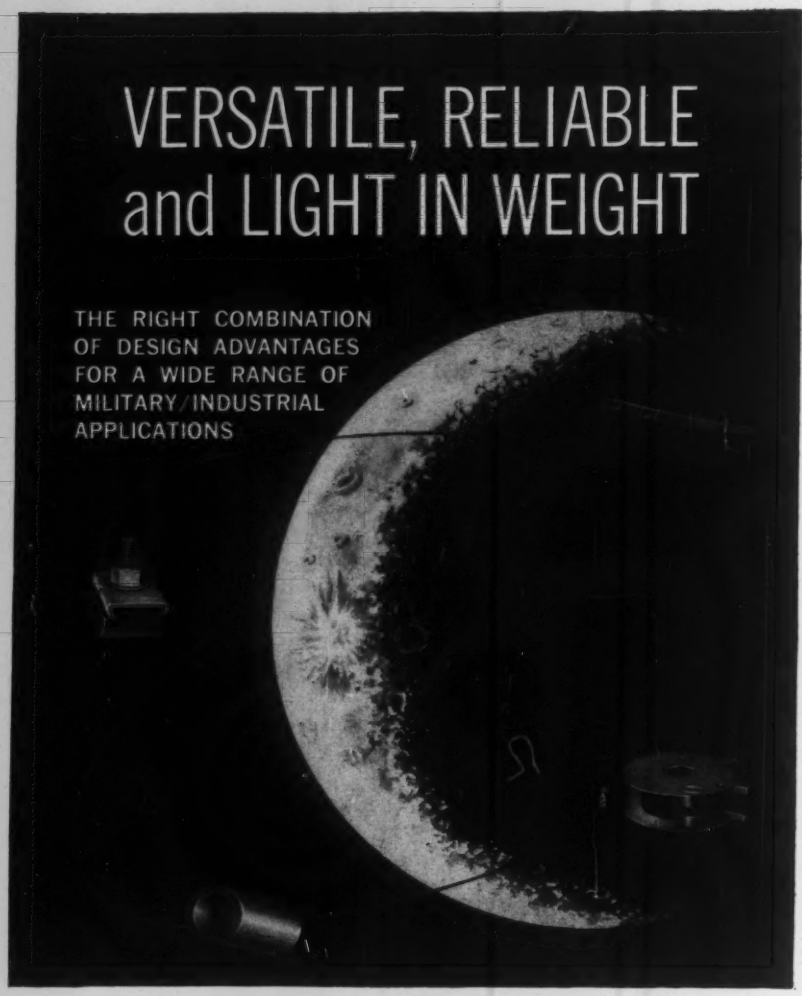

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TECHNICAL LITERATURE

nonferrous metals, and other industrial products. Particular attention is paid to more recent developments, such as automatic polishing machines; liquid polishing compositions; wet blasting processes; barreling; and polishing of light metals, die castings and plastics moldings. Also compares mechanical polishing and electro and chemical polishing.

Reports

Reinforced ceramics METAL FIBER REINFORCED CERAMICS. *J. R. Tinklepaugh and others, Wright Air Development Center, U. S. Air Force. Nov '60. 89 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.25 (PB 171 550)*

In studying the flexural properties of a ceramic-metal fiber system, it was found that the ceramic material fails when strength limits are exceeded by the load, but that the composite does not fail until the metal fibers are broken or pulled out of the ceramic. The report contains tables, graphs, charts, and descriptions of test procedures and findings.

Silicone lubricants THE STABILIZATION OF SILICONE LUBRICATING LIQUIDS ABOVE 200 C: PART 1—CONVENTIONAL OXIDATION BEHAVIOR INHIBITORS AND SOME HIGH SURFACE SOLIDS. *H. R. Baker and others, U. S. Naval Research Laboratory. June '60. 33 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1 (PB 161 314)*

Discusses a method developed by the Navy of extending the useful life of commercial silicone oils from three to five times by using oxidation inhibitors. Specific problem involved was breakdown of lubricating oils used on ball bearings at temperatures over 390 F. The inhibitors proved effective at temperatures up to about 570 F.

Air vs vacuum melting A SUMMARY OF COMPARATIVE PROPERTIES OF AIR-MELTED AND VACUUM-MELTED STEELS AND SUPERALLOYS. *D. C. Ludwigson and F. R. Morral, Defense Metals Information Center, Battelle Memorial Institute. Mar '60. 146 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.75. (PB 151 085)*

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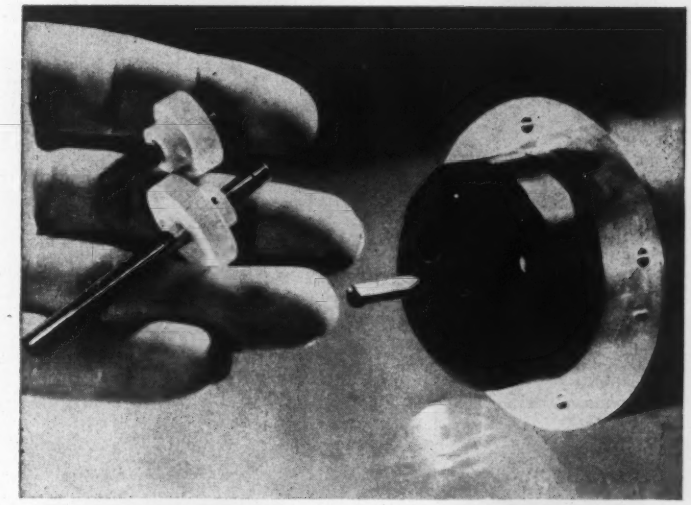

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Shear strength	5440 psi
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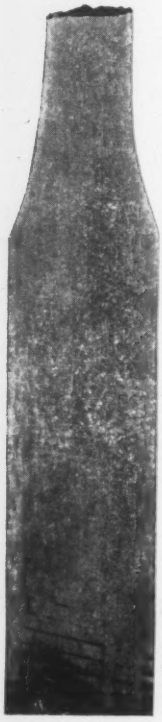

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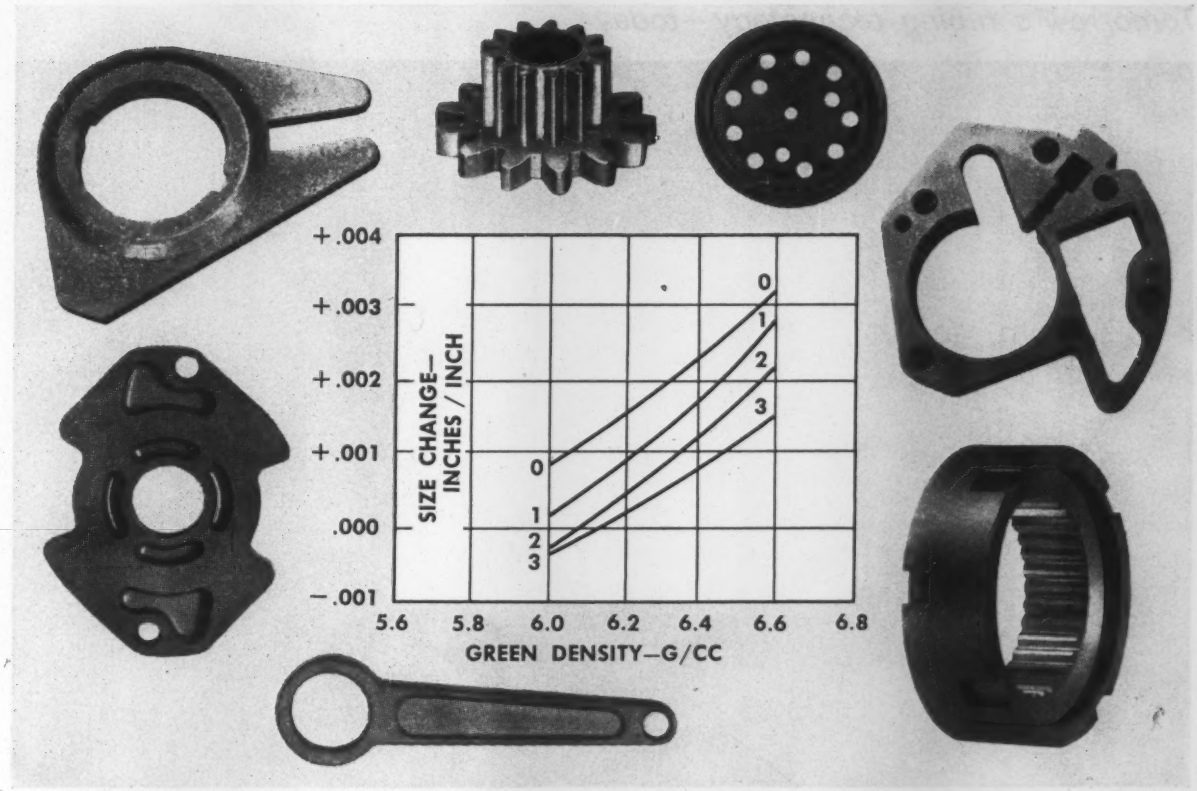

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By use of different types of carbon additives, in iron-copper-carbon mixes, a broad range of dimensional control can be achieved. This provides not only greater latitude in design specifications, but prolongs the service life of your dies. Together, these advantages result in closer tolerances for your molded parts at reduced production costs.

The curves shown above indicate the range of dimensional change obtainable with various types of carbon. *The cost of all these grades is almost identical.*

The Alan Wood 50-ton-a-day direct reduction plant, backed by years of metallurgical research, offers you the most advanced technology in Iron Powder. Make Alan Wood your Iron Powder headquarters for dependable uniformity and delivery, as well as technical advisory service.

ALAN WOOD STEEL COMPANY
CONSHOHOCKEN, PA.

FOR MORE INFORMATION

IRON POWDER DIVISION
ALAN WOOD STEEL
COMPANY
Conshohocken, Pa.

Please send me A.W. Technical Data Bulletin #3, which gives additional details on copper-carbon additives.

NAME AND TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____

AMERICAN STEELMASTERS FOR 135 YEARS

For more information, turn to Reader Service card, circle No. 338

Tomorrow's tubing technology—today

Superior (SAE) hydraulic quality tubing—strength plus formability for safer systems

There are many reasons why Superior (SAE) hydraulic quality tubing is specified for application in hydraulic systems operating under pressures up to 3000 psi. It has an ultimate tensile strength of 60,000 psi max., a yield strength of 25/45,000 psi, and an elongation of 35/45% in 2 in. It has a recommended maximum working pressure range of 530 to 11,750 psi, depending on OD and wall thickness. Every length is hydrostatically tested under maximum working pressure. It is made of non-aging steel, maximum carbon content 0.12%. It is specially coated with a waxlike rust preventive.

Superior (SAE) hydraulic quality tubing has other important advantages too. It can be easily bent into angle turns or sweep bends—pipe fittings, which are subject to leakage, are eliminated. It does not require threading, which removes metal and weakens the wall. It absorbs vibration by reducing the number of fittings needed and by providing the required strength with minimum wall thickness. It has a bright, smooth, scalefree interior to minimize turbulence and pressure drop.

No matter what your small-diameter tubing requirements are, we can satisfy them. In addition to (SAE) hydraulic quality tubing, we offer more than 120 analyses in quantities from 50 to 1,000,000 ft. Sizes range from .010 in. to ⅝ in. OD. Bulletin 39 gives complete details about Superior (SAE) hydraulic quality tubing—write for a copy today. Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

West Coast: Pacific Tube Company, Los Angeles, California

For more information, turn to Reader Service card, circle No. 321

For more information, circle No. 415 ➤

GOODYEAR

Photograph taken with cooperation of The Sorg Paper Company, Middletown, Ohio, and American Tag Company, Chicago, Illinois

They ended the "deadlocks"—cut labeling costs 52%—with CHEMIGUM LATEX!

An annoying problem for meat packers was labeling hot, freshly skinned beef. Ordinary labels wouldn't stick. Notations were blurred by the grease. The only answer was tags applied with metal "deadlocks" or hooks—a costly, time-consuming operation.

A cheaper, better solution was found, however, in paper impregnated with CHEMIGUM LATEX. Its toughness plus resistance to grease and moisture—over a range of temperatures—permitted labels that remained in place, intact and clearly legible, yet peeled off cleanly. That ended the deadlocks at a healthy 52% savings in label costs.

How can CHEMIGUM LATEX beef up your paper product? Unusual toughness, flexibility, tear strength, and resistance to moisture, oil, solvents and chemicals, are just some of the properties you get—easily and economically—through beater impregnation or saturation with CHEMIGUM LATEX. For technical details, samples and help with your application, write Goodyear, Chemical Division, Dept. J-9437, Akron 16, Ohio.

Lots of good things come from

GOODYEAR

CHEMICAL DIVISION

Chemigum—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many who may find it useful to review fundamentals from time to time.

Steel

for Strength . . . Economy . . . Versatility

Tests for Determining Mechanical Properties of Alloy Steels

The types of tests used to evaluate the mechanical properties of an alloy steel depend upon the end use of the steel involved. Mechanical properties are determined usually by tension, bend, and hardness tests, and by a group of special tests employed on tubular and wire products.

(1) *Tension tests* provide means of determining tensile strength, yield point, yield strength, proof stress, proportional limit, per cent elongation, and per cent reduction of area. This sort of test subjects the steel to stresses resulting from the application of an axial tensile load to the specimen ends, the load being sufficient to rupture the specimen.

(2) *Bend tests* often aid in determining the ductility of steel. The severity of such a test depends largely upon the bending radius used. Several factors influence the length of radius, including thickness of the test specimen, width of test specimen, direction of test, chemical composition, tensile strength of specimen, etc.

(3) *Hardness tests* determine the steel's resistance to penetration. This characteristic is most commonly measured by the Brinell Test or the Rockwell Test. In the former, pressure is applied to the surface of a test specimen by means of a ball 10 mm in diameter. Two diameters of the resulting impression are measured and averaged; the average is converted to the hardness number by means of a conversion table. In the Rockwell Test, the degree of hardness is read on a gage; hardness is measured by the penetration of a diamond point or a 1/16-in. steel ball. Rockwell "C" scale readings are used in connection with the diamond point; "B" scale in connection with the steel ball. The "C" and "B" are the most commonly used of the several Rockwell scales.

(4) *Special additional tests* are often made on tubular and wire products. These include such items as hydrostatic and manipulating tests, and torsion and wrapping tests, the latter two being used only with wire.

The subject of testing and its relationships to the end uses of alloy steels has been given broad study by Bethlehem metallurgists. If you desire, they will be glad to discuss any phase of it with you, and also give unbiased opinions on such matters as analysis, proper selection of steels, machinability, etc. Call for their services at any time.

And when you need alloy steels, remember that Bethlehem furnishes the entire range of AISI standard analyses, as well as special-analysis steels and all carbon grades.

This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Sales:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, turn to Reader Service card, circle No. 378

Wear like this led to replacement of 7 metal parts by ADIPRENE

Highly abrasive glass dust caused this reciprocating rod to cut entirely through a metal bearing and most of the cylinder rod end plug in a UNIFIL® loom-winder used in glass fabric weaving. An ADIPRENE bearing was still performing well a year later, after more than 200 million strokes.

ADIPRENE® still at work after 200,000,000 strokes...on a job too tough for metal bearing

Tiny glass particles ground gaping holes in vital metal parts on glass fabric weaving equipment. An obvious solution was substitution of non-metallic parts. But when conventional rubbers and plastics were tested, failure again occurred. ADIPRENE urethane rubber, however... with its excellent resistance to abrasion, plus its combination of hardness, resilience, and load bearing capacity... tested so successfully that now seven ADIPRENE parts are used in the same loom-winding machine. These parts reduce downtime and increase quality by making possible continuous runs of the glass fabric.

ADIPRENE can help you in the design of better, longer-lasting parts. It is oil-resistant, machinable and has outstanding electrical properties. For detailed information on the unusual combination of properties of ADIPRENE, write E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department MDE-10, Wilmington 98, Delaware.

Conventional Rubber **ADIPRENE**

Conventional rubbers were also tested for textile machinery parts. ADIPRENE far outlasted all metals, plastics and rubbers.

DU PONT REG. U. S. PAT. OFF.

ADIPRENE®
URETHANE RUBBER

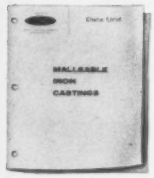
Better Things for Better Living . . . *through Chemistry*

For more information, turn to Reader Service card, circle No. 394

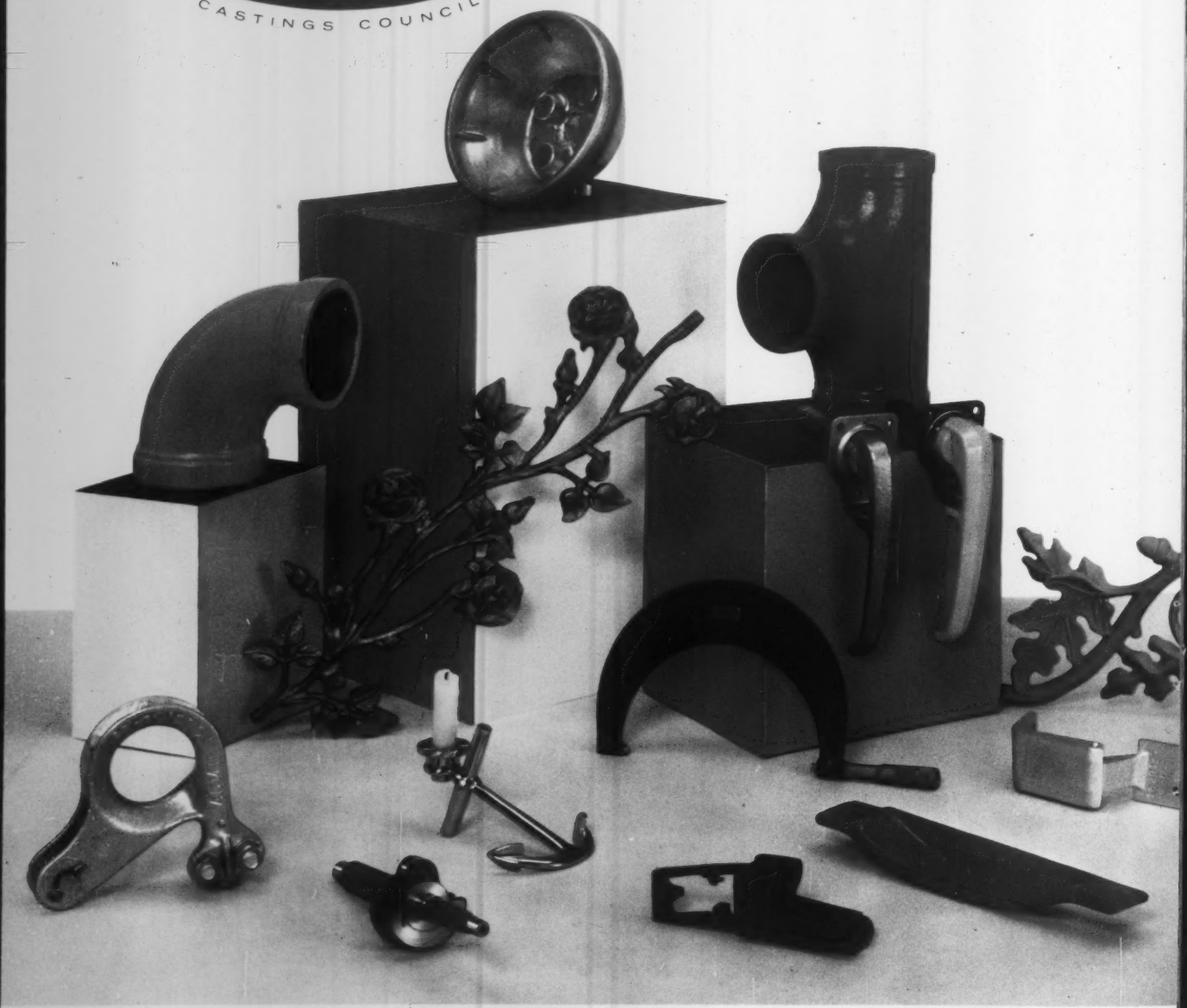
Now—Finishes Add Beauty to Tough Malleable Castings

Beautiful, protective finishes on tough Malleable iron castings will give your products a superior combination of appearance, ruggedness, and economy. Get complete information on this sales-getting combination from any of the progressive companies that display this symbol —

MEMBER
MALLEABLE
CASTINGS COUNCIL



New Ideas for your products are suggested in Data Unit No. 115, available free from any member of the Malleable Castings Council, or write to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.



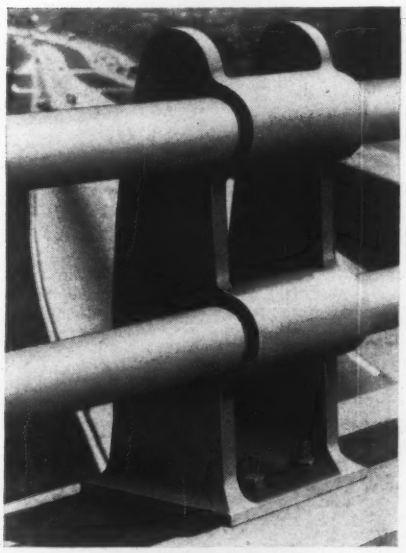
The castings shown have been painted, blued, chromium and cadmium plated, plastic coated, porcelain enameled, galvanized, and machined.

When appearance and long service life are important to your products, Malleable castings offer many advantages. Painting, hot dip galvanizing, blueing, and electroplating have long been used with Malleable castings because of their economy, attractiveness, and resistance to a variety of destructive conditions.

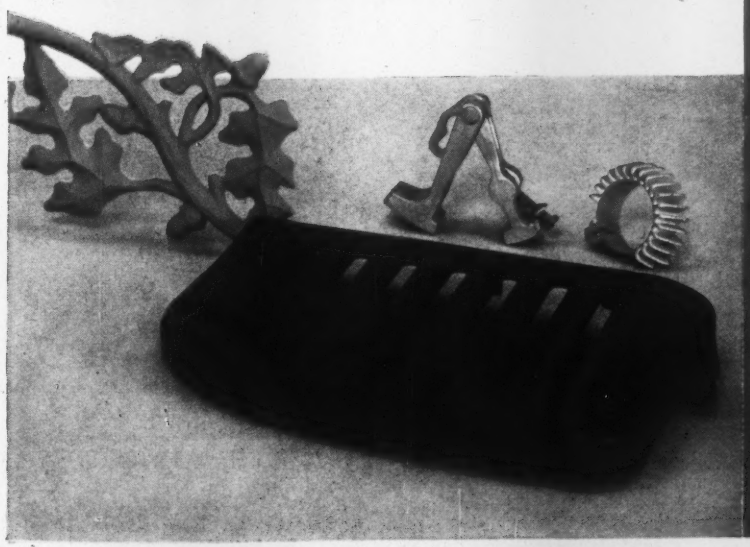
Several exciting new finishes appear very promising and are currently being tested by Malleable producers. Vinyl plastic in thin, contour-hugging films or thick, resilient coatings provide exceptional chemical resistance, and are available in a wide spectrum of strikingly beautiful colors.

Another attractive finish is porcelain enamel. In addition to smooth, gleaming surfaces in unlimited colors, it has excellent resistance to heat and chemicals.

The variety of finishes which can be successfully applied to Malleable gives designers outstanding opportunities to combine decorative and protective surfaces with the rugged dependability, economy, and versatility of Malleable castings. Call your Malleable supplier for information and quotations.



Bridge railing posts on the Connecticut Thruway are Malleable castings for three important reasons: (1) strong, ductile Malleable offers far greater resistance to fracture upon collision than other materials tried, (2) Malleable is easily galvanized for additional salt air corrosion resistance, and (3) with thousands of these posts in use, Malleable's economy produced real savings.



For Quality and Economy Use

MALLEABLE

For Service Contact...

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Alloy Foundries Division, The Eastern Co., Naugatuck

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Iron Works, Moline
Moline Malleable Iron Co., St. Charles
National Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Albion Malleable Iron Company, Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division The Eastern Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
National Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

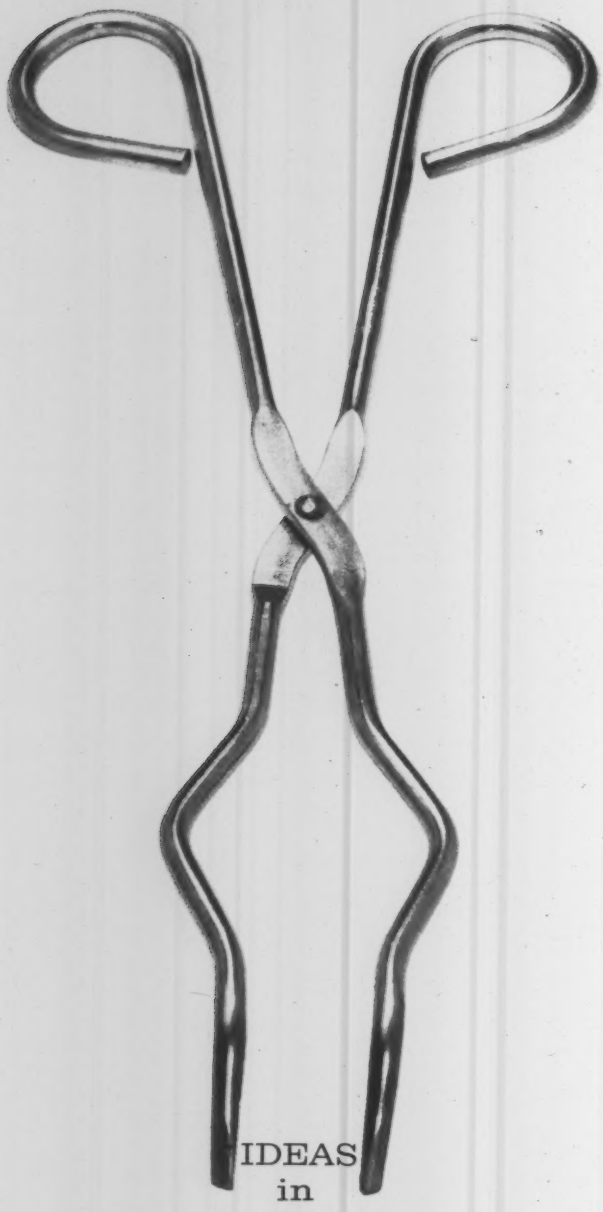
TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

These companies are members of the Malleable Castings Council

For more information, turn to Reader Service card, circle No. 326



IDEAS in chemistry from Norton

Thermal stability . . . unusual purity. This is what the research chemist looks for in refractory materials. Norton Company offers him both.

Hydrogen for a variety of applications is available today from high temperature reactors lined with fused aluminum oxide refractory material. The requirement here is to contain the reaction . . . *containment without contamination*. Norton material meets the need. One important use of this hydrogen . . . which can be made anywhere . . . is in ammonia-base fertilizers for sub-marginal land.

Maleic and phthalic anhydrides, and ethylene oxide, are products of reactions which offer a similar challenge. The catalyst carriers for these reactions must have heat resistivity, uniform size and porosity, and a purity not commonly found in ceramic materials. Norton pioneered their development, and has a fund of knowledge for anyone interested in catalysis.

In the chemical industry as in other fields, Norton is crystallizing ideas into products . . . through oxide chemistry, and through fundamental work in carbides, nitrides and borides. We are ready to work with you. Write NORTON COMPANY, Refractories Division, 349 New Bond St., Worcester 6, Massachusetts.

NORTON
REFRACTORIES
Crystallizing ideas into products

For more information, turn to Reader Service card, circle No. 324

For more information, circle No. 389 ➤

Computer Analyses Now Make Tenzaloy Better Than Ever

TENZALOY

Asarco has introduced another significant advance in aluminum casting alloy technology — computer correlation of composition and properties of its widely used high-strength, self-aging Tenzaloy. Results: Further refinement in quality and reliable performance of this superior alloy.

Data for the pioneering computer analyses were drawn from a long record of properties and composition of Tenzaloy plant heats compiled by Asarco's Central Research Laboratories. From these studies has come new knowledge of the interaction of Tenzaloy elements and effects of alloying ingredients on mechanical properties.

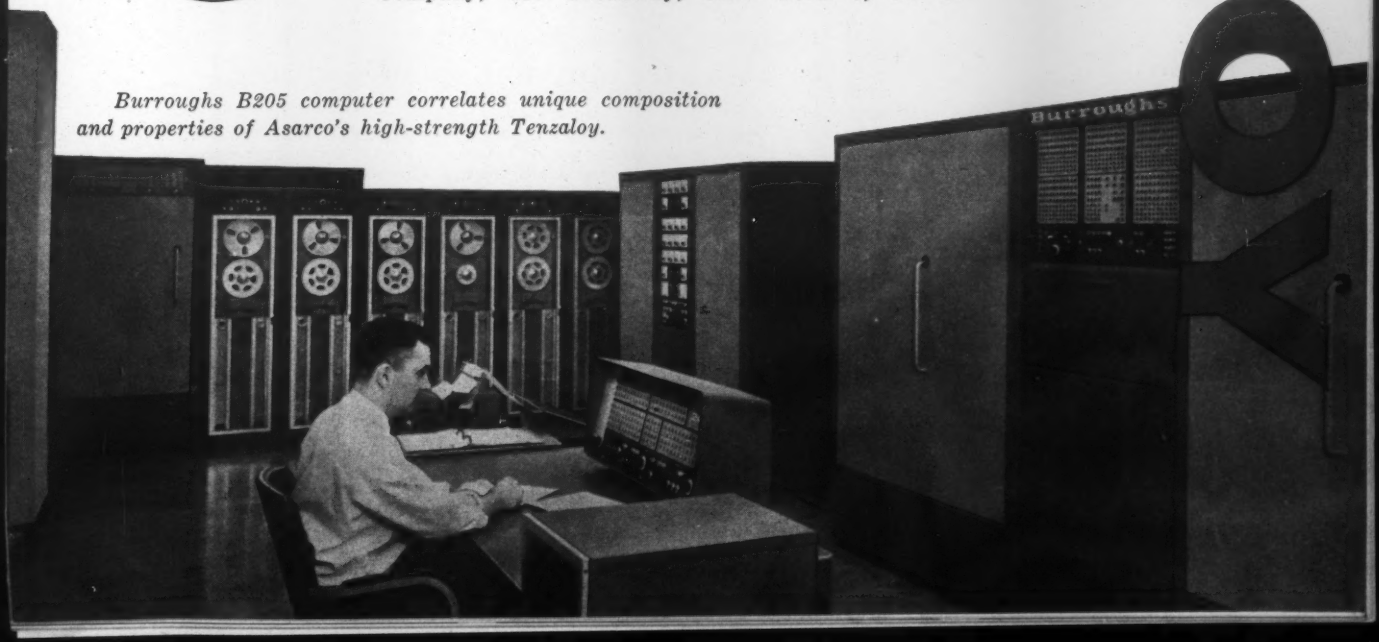
Computer findings now enable Asarco metallurgists to control Tenzaloy mechanical properties to a much narrower range of variation and to higher average values than ever before — and to reproduce them precisely and consistently over and over. There is only one Tenzaloy and it cannot be duplicated.

TYPICAL PROPERTIES OF TENZALOY

	SAND CASTINGS	PERMANENT MOLD CASTINGS
Tensile Strength	35,000 psi	40,000 psi
Yield Strength	25,000 psi	27,000 psi
Elongation (in 2")	4-5%	6-7%
Brinell Hardness No.	74	74
Impact Strength (Charpy in ft./lbs.):		
Notched	3	3
Un-notched	14	20
Electrical Conductivity	30%	30%

Tenzaloy can widen design horizons, increase production efficiency, reduce costs and improve your products. For your copy of Bulletin 103R5, "Tenzaloy, the Self-Aging Aluminum Casting Alloy," write today to: Federated Metals Division, American Smelting and Refining Company, 120 Broadway, New York 5, N. Y.

ASARCO



Burroughs B205 computer correlates unique composition and properties of Asarco's high-strength Tenzaloy.

FAIRMONT

the aluminum source that gives you **ALL FOUR**

1 QUALITY: Exactly according to your specifications every time. Reason—Fairmont's modern precision equipment and the most rigid quality-control system in the business.

2 ENGINEERING: You get practical help, not just sales talk, from Fairmont field men who are qualified engineers with mature experience in aluminum and its applications.

3 AVAILABILITY: All Fairmont products are rolled every day. You can depend on getting what you need when you need it, custom-rolled and on the way fast.

4 DELIVERY: Your order gets personal attention *all* the way. Fairmont's own truck fleet, operated by specialists in aluminum handling, guarantees prompt, dependable delivery.

ALUMINUM

rolled every day by Fairmont in all these categories

ALLOY	TEMPER	SHEET	COILS	CIRCLES	FINISHES PLAIN	FINISHES EMBOSSED	TYPICAL ALLOY APPLICATIONS
1100	O, H-12, H-14, H-16, H-18	X	X	X	X	X	Refrigerator parts, fins for heating-air conditioning
3003	O, H-12, H-14, H-16, H-18	X	X	X	X	X	Cooking utensils, doors, wall tile, awnings
3004	O, H-32, H-34, H-36, H-38	X	X	X	X	X	Truck bodies, building panels, electronic application
5005	O, H-12, H-14, H-16, H-18	X	X	X	X	X	Small stampings, trays, rolled shapes, weather stripping
5050	O, H-32, H-34, H-36, H-38	X	X	X	X	X	Window screens, jalousies, auto trim, TV cabinets
5052	O, H-32, H-34, H-36, H-38	X	X	X	X	X	Home freezer liners, display racks, hardware
5357	O, H-32, H-34, H-36, H-38	X	X	X	X	X	Decorative applications where anodized finishes are involved
5457	O, H-32, H-34, H-36, H-38	X	X	X	X	X	Decorative applications where anodized finishes are involved
5557	O, H-32, H-34, H-36, H-38	X	X	X	X	X	Decorative applications where anodized finishes are involved
BLDG. SHEET	H-12, H-14, H-16	X	X	X	X	X	Building specialty products, siding, roofing, panels

. . . Get Fairmont's new Aluminum Selector Guide to help you pinpoint specifications

Here's a complete field of aluminum know-how at your fingertips, based upon Fairmont's 35 years of comprehensive experience. Fairmont's new *Selector* and Design Data Guide is an indispensable reference if you use aluminum sheet, coils, circles, in plain, matte or embossed finishes. Enables you—at a glance—to match best combination of aluminum properties to your specific applications. Includes tabulation of chemical and physical properties, application data on aluminum alloys, plus weights, and helpful specification data. For your free copy, write *Vice-President, Sales, Dept. 25-J, Fairmont Aluminum Company, Fairmont, West Virginia.*

FAIRMONT ALUMINUM COMPANY

SUBSIDIARY OF **CERRO CORPORATION**

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FAIRMONT • WEST VIRGINIA

FAIRMONT 3010 • CABLE ADDRESS: FARMON

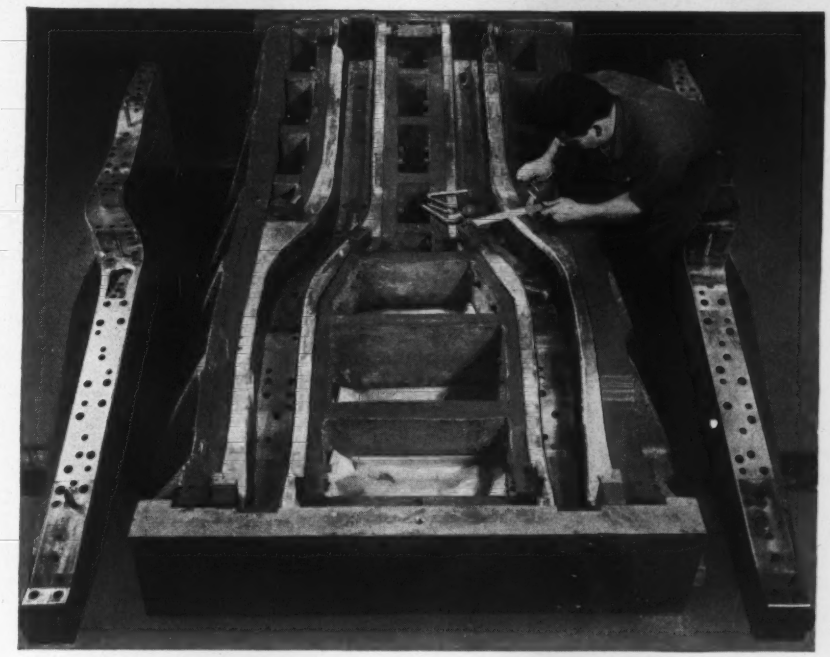
For more information, turn to Reader Service card, circle No. 377

Steel
for Strength
. . . Economy
. . . Versatility

Tool Steel Topics

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation



Die of AH-5 Tool Steel
Forms Sheet Steel Auto Frames

This huge die, of Bethlehem AH-5 tool steel, was made by Parish Pressed Steel Division of Dana Corporation to form automobile frames. Hardened to Rockwell C 60-62, the die handles sheet steel .120 in. thick.

Engineers at Parish like the wear-resistance of AH-5, which enables them to produce about 25,000 frames before slight redressing of the die becomes necessary. AH-5's low distortion and good shock-resistance were also singled out for favorable comment.

AH-5 is an air-hardening grade containing 5 pct chromium. It's an easy steel to machine because it can be annealed to 212 Brinell. Here's its typical analysis:

Carbon 1.00 Chromium 5.25
Manganese 0.60 Molybdenum 1.10
Vanadium 0.25

AH-5 assures economical, long-run performance from forming and blanking tools, dies, and punches. For full particulars about AH-5 or any of our other air-hardening tool steels, get in touch with your Bethlehem distributor.

• • • • •

For maximum wear use LEHIGH H

A maker of beer can openers produced several million pieces with die of Lehigh H (our AISI D-2 grade). Lehigh H provides outstanding wear-resistance in a variety of difficult applications because of its high concentration of well-distributed carbides.

It's also easy to machine. An air-hardening grade, Lehigh H has a high-carbon, high-chrome analysis.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Here Are the Facts on Clearance:

It's the Blank That Tells the Story

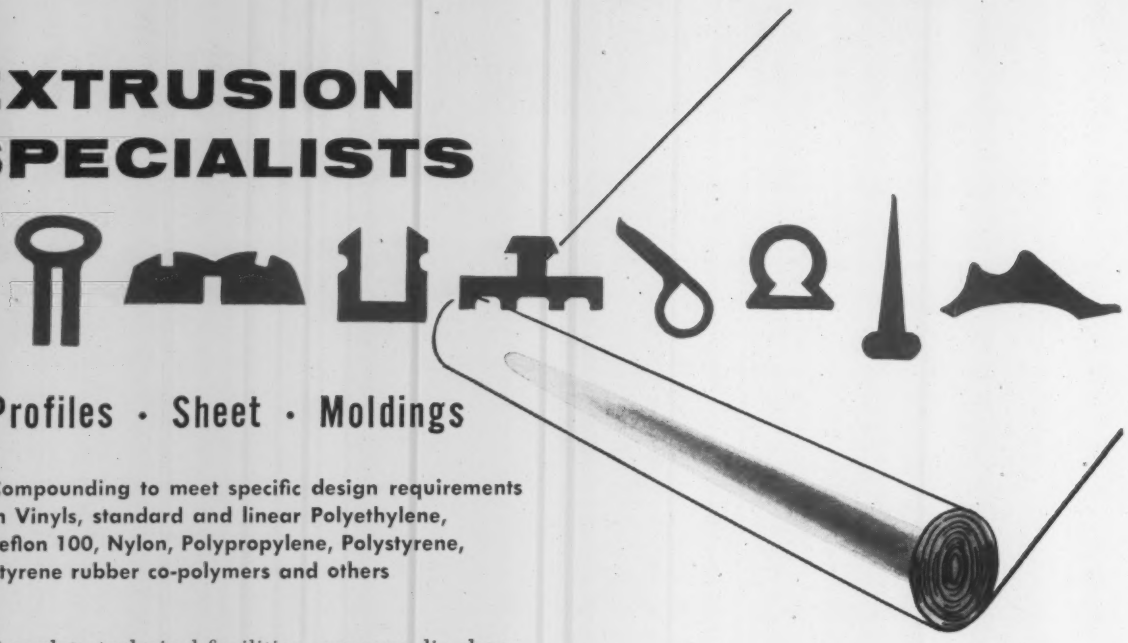
Operators of punching, blanking, and shearing equipment recognize that proper clearance between punch and die is necessary for good operation. The right amount of clearance produces the lowest cutting pressure and the least wear on the tools, and also makes possible clean, sheared edges which are free from burrs.

The most common rule for clearance is this: clearance should be about one-tenth the stock thickness. Yet in many shops there's a continual search for some "magic" formula that will more accurately determine the proper clearance . . . which in turn will automatically eliminate whatever type of trouble is current.

There is no need to wait for such a formula to be developed because it is not actually needed. Examination and evaluation of the blanks, or sheared edges being produced, will tell whether the proper clearance is being used. Sheared edges produced with proper clearance will show "shear" (the smooth, shiny portion) for about 1/5 to 1/3 the stock thickness; the remainder of the edge will show "fracture". (this is the rough, granular part). If the "shear" occupies too great a portion of the thickness, it indicates the clearance is too great; when the "shear" is too little, insufficient clearance is indicated. If heavy burrs are present on the sheared edges, and if the blanks are "cupped," then the clearance is too great. Burrs on portions of the sheared edges may indicate misalignment or dull tool edges which, in effect, change the clearance from the amount theoretically present.

Developing and maintaining proper clearance pays off in the production of high quality parts, and also results in minimum tool wear and low tool costs.

EXTRUSION SPECIALISTS



Profiles · Sheet · Moldings

Compounding to meet specific design requirements in Vinyls, standard and linear Polyethylene, Teflon 100, Nylon, Polypropylene, Polystyrene, Styrene rubber co-polymers and others

Complete technical facilities, our own die shop, a wide range of extruder types and sizes, and rigid quality control standards, enable Conneaut to deliver quickly top-quality extrusions, competitively priced.

We can, for example, provide plastic sheet, either rigid or elastomeric, for fabrication by heat welding or vacuum forming, in gauges from .025″ to .250″ in various widths. We can furnish extrusion molded slugs up to several hundred pounds for further machining in your plant or we can furnish the final part machined to your specifications. Formulations can be varied to meet design requirements. For nuclear applications, additives such as elemental boron, boron carbide, lead oxide or cadmium oxide can be incorporated. We can furnish profiles in any extrudable cross-section to extremely close tolerances and hold the tolerances through the length of the run. If desired, we can heat-seal, punch or otherwise fabricate the extruded profile to your specifications.

IF IT IS EXTRUDABLE IN PLASTIC
CONNEAUT ***CAN EXTRUDE IT***
Quickly, Accurately, Economically

Write, wire, or phone 51-961, Conneaut, for prompt information, project analysis, recommendations or quotations.

The new research facilities of Conneaut Rubber & Plastics Co.

1844-A

CONNEAUT
RUBBER & PLASTICS CO.

CONNEAUT, OHIO

A UNIT OF
THE UNITED STATES STONEWARE COMPANY

For more information, turn to Reader Service card, circle No. 409

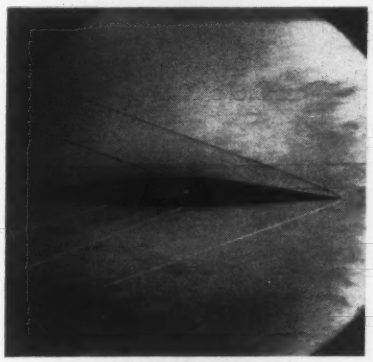
THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING

A LOOK AT TRANSPARENCY

One of the most useful qualities of glass is that you can see through it. In almost a century of experience, we've learned how to balance *other* useful properties of glass with transparency to give designers windows onto all sorts of worlds.

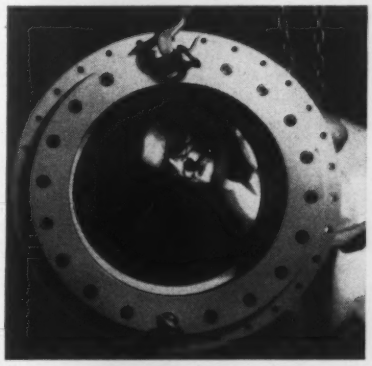
This small compendium on transparency-plus may give you an idea or two on how to get a look at whatever you'd like to watch.



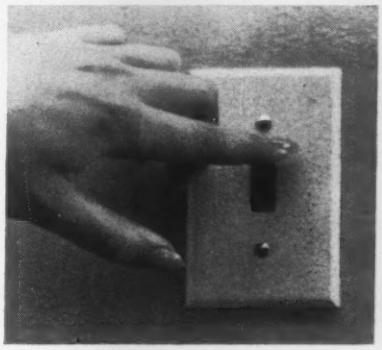
The window through which this schlieren photograph was taken is 99.999+% fused silica, the most transparent glass for visible light ever made. Its extremely low coefficient of expansion gives it extremely high heat shock resistance. Couple these properties with a low refractive index variation and complete absence of physical flaws, and you have a window glass for such applications as this North American Aviation supersonic wind tunnel.

To study the impact of two opposing gas waves traveling at Mach 80, physicists at Boeing Laboratories take photographs through a 12-foot length of 6″ O.D. PYREX glass pipe. This is the same borosilicate glass we use in pipe for chemical and food processing plants and for drainlines and heat exchangers.

A quarter-inch polished plate of PYREX brand infrared reflecting glass keeps this steel mill crane operator cool. The glass bounces as much as 93% of the infrared, yet transmits about 75% of the visible light.

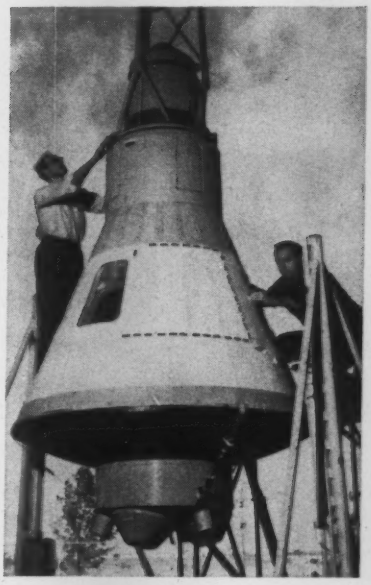


This is a radiation shielding porthole which lets sailors on nuclear-powered submarines look directly, and safely, into the reactor chamber. It's made of a high-lead-content glass which stops gamma rays. For other hot cells, we've turned out shielding windows as big as five feet thick and nine tons heavy.



The mercury that makes this light switch noiseless is enclosed in a PYREX® tube. Transparency makes preassembly inspection easy. Other features: the mercury can't corrode the glass; the glass serves as electrical insulation, and it can be sealed to metal.

A different kind of heat comes from a welding torch. This VYCOR® brand glass nozzle lets the welder keep a close eye on his work, but isn't affected by the heat. VYCOR brand glass is 96% silica, approaches fused silica in heat shock resistance.



Four-paned spaceports go into the Project Mercury capsules. Two panes of VYCOR brand glass and two of aluminosilicate glass provide optical quality plus the space traveling necessities of great physical and thermal strength coupled with low weight.

AND FURTHERMORE...

We have certain brochures and bulletins which explore more deeply the design possibilities of glass, with specific reference to transparency. We'll be glad to send you any or all of them upon receipt of the coupon.

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS, 5010 Crystal St., Corning, N.Y.

Please send information on:

☐ IR Reflecting Glass ☐ PYREX Pipe ☐ Flat Glasses ☐ VYCOR ☐ Fused Silica

Name..... Title.....

Company.....

Street.....

City..... Zone..... State.....

For more information, turn to Reader Service card, circle No. 333

E. F. HAUSERMAN COMPANY KNOWS . . .

Strong
Modern
Dependable

Steel

Hauserman "Delineator" and "Signature" movable modular wall systems offer custom styling, plus all the advantages of prefabrication. Republic Custom Service assures perfect panel surfaces, even in newest, biggest five-foot cold rolled steel panels.

REPUBLIC HAS THE FEEL FOR MODERN STEEL

PERFECT PANELS FIVE FEET WIDE!

Color is one of the simplest and most powerful means of creating psychological environment. E. F. Hauserman Company uses color most dramatically in their new "Delineator" and "Signature" movable modular wall systems—but without perfect panel surfaces, the final striking effect could only be achieved at prohibitive expense.

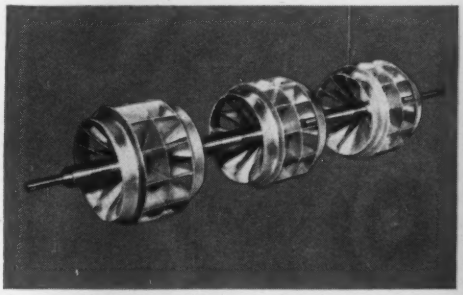
Surface quality is made even more significant by the addition of a five-foot-wide "maximum panel" to the "Delineator" and "Signature" systems. This is quite an expanse of steel—and application of the high quality surface finish could very well reveal a number of disappointing faults. Not here, though. Republic 19-gage Cold Rolled Steel, engineered for the application, is flat, smooth, and clean, as received . . . ready to contribute its share to distinctive good looks.

Republic Custom Service is the answer . . . custom metallurgy, custom mill production, custom quality control and follow-up, to make certain that material meets end-use requirements—perfectly.

You can avoid disappointment in production, too. Get more information on Republic Custom Controlled Hot and Cold Rolled Sheet and Strip. Mail the coupon . . . or call your nearby Republic distributor!

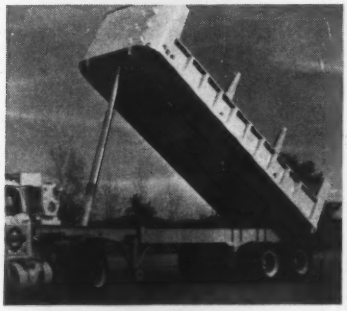
REPUBLIC STEEL

REPUBLIC HAS THE FEEL FOR MODERN STEEL



CUSTOM MADE to meet close tolerance concentricity requirements, Republic ELECTRUNITE Mechanical Tubing is used to produce this rotor shaft. Exact balance is imperative, to maintain precisely balanced operation at speeds as high as 1110 rpm., in lengths of as much as 94″.

CUSTOM METALLURGY permits a severe draw in production of this stainless steel auto window trim. Republic Field Metallurgists, called in when the manufacturer reported badly roped surfaces, recommended a variation of Republic Type 430 Stainless—and solved the problem!



CUSTOM COMBINATIONS of high strength, toughness, corrosion resistance, and abrasion resistance in Republic High Strength Steels make possible weight savings up to 33%. Ask about the four Republic High Strength Steels: "50", "M", "65", and "70"; available in bars, plates, sheets, and strip.

REPUBLIC STEEL CORPORATION
DEPT. ME-2663
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Send literature describing Republic Custom Service on:

- ☐ Hot and Cold Rolled Steel Sheet and Strip
- ☐ ELECTRUNITE® Mechanical Tubing
- ☐ High Strength Steel
- ☐ Stainless Steel

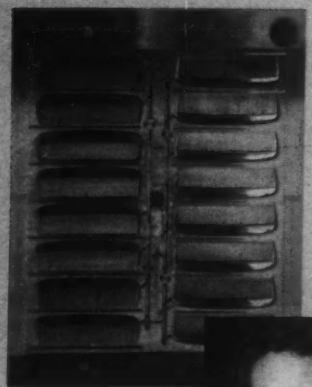
Name_____ Title_____

Company_____

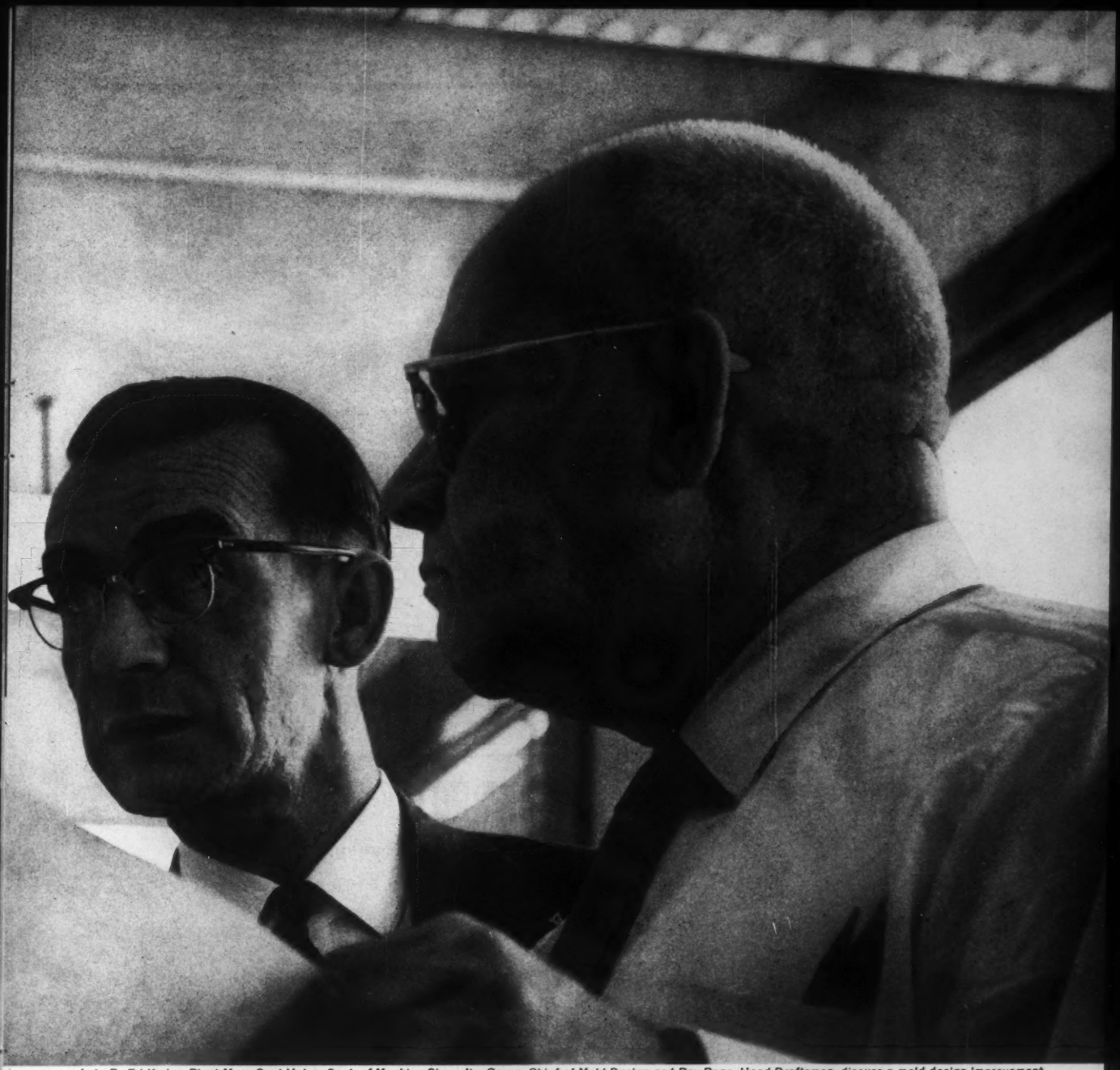
Address_____

City_____ Zone_____ State_____

For more information, circle No. 429



"These men helped solve a customer's mold design problems. Maybe they can solve yours," says Joe Foster.



L. to R.: Ed Kodys, Plant Mgr.; Onni Heino, Supt. of Machine Shop; Jim Crane, Chief of Mold Design and Roy Page, Head Draftsman, discuss a mold design improvement.

In fact, they may have solved yours already... for the Foster Grant experts shown here are some of the top men in their respective fields. And during their long careers with us they have participated in many significant industry advances.

Our own molding experience, as the world's largest manufacturer of sunglasses, has resulted in a unique know-how which often proves of real value to our resin customers.

Case in point – a leading comb molder using Fostarene and Fosta Nylon resins. A couple of years ago we invited him to inspect our operation in Leominster. He did and decided that some of our ideas might be worth adapting for use in his own plant.

So we helped design improved molds for him, based on his particular needs, and tested them *on his own machines.* Result – sixteen combs per "shot" instead of eight, 26% shorter cycling time, semi-automatic instead of hand de-gating, and an end to grinding and buffing... for a total yearly saving of more than $100,000!

What we give away is more valuable than what we sell. For more information about our unique experience and our ability to serve *you* with *production proved plastics,* why not call or write us today? Foster Grant Co., Inc., Leominster, Massachusetts, KEystone 4-6511.

FG

For more information, circle No. 446

Your partner in Plastics Progress **FOSTER GRANT**
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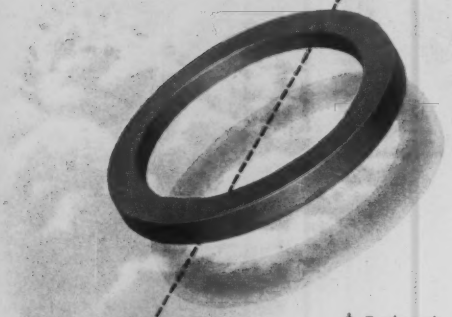
get
the
GOSHEN RUBBER IDEA*



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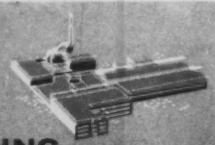
IN
TETRASEALS†

***to precisely fabricate parts, seals, and components** from selected compounds, and for specific applications only!

If you use O-rings, then you'll want to consider TETRASEALS for direct O-ring substitution, size for size, from 3/16" up to 15" ID. These *rectangular* section rings can save you money and render outstanding sealing performance in most static and some moving applications. Tetraseals use the same groove as standard O-rings, require no special tooling, and are one-piece (non-laminated). And they're available only from GRC . . . in natural, synthetic and silicone rubber compounds to meet MIL, AMS, SAE, ASTM and industrial specifications.

NEW TETRASEAL BROCHURE

12 pages of useful information, available sizes and dimensions . . . free for the asking.



Goshen
RUBBER CO., INC.
3110-1 S. TENTH ST. • GOSHEN, INDIANA
Phone KEystone 3-1111 TWX: GOSH 8701

For more information, turn to Reader Service card, circle No. 347

FOR TOP OF THE LINE MODELS

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Magic Chef®
TURNS TO G.E.I.
Instrument panels of Magic Chef ranges are framed in the magic metal—aluminum . . . extruded, fabricated and anodized by GENERAL EXTRUSIONS, INC. This is another example of a leading manufacturer solving his requirements for durability, beauty and utility with G.E.I.'s uniform quality and unfailing delivery. Discuss your extruded aluminum needs—one part or a million—with G.E.I.
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C BACKGUARD TOP
A BACKGUARD BOTTOM
TRIM FRONT CENTER
B
MOUNTING BRACKET

For more information, turn to Reader Service card, circle No. 437

CERROTECHNICS *saves* TIME & MONEY

in Anchoring Punches

in Punch Plates

CERROTECHNICS—the technology of using CERRO* ALLOYS to expedite industrial operations.

Guided by die plate, punches are located in oversize holes in punch plate. Cap screws inserted into punch bases through auxiliary plate hold punches while CERROMATRIX is poured. Cuts cost 50% to 90%. Send for full information.

*T.M. Cerro Corp.

CERRO SALES CORPORATION
SUBSIDIARY OF CERRO CORPORATION
Room 1504, 300 Park Avenue, New York 22, N. Y.

For more information, turn to Reader Service card, circle No. 451

NEW from Rohm & Haas!

IMPLEX R

the NEW, SUPER HIGH IMPACT, formulation in the IMPLEX® family of tough, rigid acrylic molding powders

- **MAXIMUM IMPACT STRENGTH**—*Double* the highest impact strength previously available in IMPLEX acrylic molding powders.
- **LIGHT TRANSMITTANCE**—High degree of transparency in natural color, resulting in *increased range of colors . . . more color brilliance . . . more color depth.*
- **GOOD MOLDABILITY**
- **EXCELLENT STABILITY**—Dimensionally stable—no plasticizer . . . low water absorption . . . resistant to chemicals and staining . . . free of odor or taste.
- **HIGH SURFACE GLOSS**—Lustrous, smooth surfaces in a complete range of rich, deep colors.

Write today for color samples, technical data and table of physical properties on IMPLEX R—for SUPER HIGH IMPACT in quality molded parts.

ROHM & HAAS

PHILADELPHIA 5, PA.

For more information, turn to Reader Service card, circle No. 441

OHIO *Round Tubing*
To 7-1/2" OD x .375" wall

OHIO *Square Tubing*
To 6" x 6" x .259" wall

OHIO *Rectangular Tubing*
To 7-1/2" major diameter x .259" wall
Typical 4" x 6" x .259" wall section illustrated

Announcing Mechanical — Pressure — Cold Drawn

OHIO QUALITY WELDED STEEL TUBING

in larger sizes...heavier wall thicknesses

OHIO SEAMLESS TUBE

Division of Copperweld Steel Company • **SHELBY, OHIO**

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

New sizes and heavier wall thicknesses of Ohio Quality Welded Steel Tubing (up to 7½" OD) now parallel the sizes of famous Ohio Seamless Steel Tubing. That means — now more than ever — there's a type and size of Ohio tube to fit your special requirements exactly. And since we make both types, we're in a position to recommend the best type for your own particular needs. Ohio Tubing — either welded or seamless — is just "made to order" for your product.

For more information, circle No. 434

Cut along line and send air mail to save time.

RUSH me, without obligation, latest information on new larger sizes and heavier wall thicknesses of Ohio Welded Steel Tubing.

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Company _____

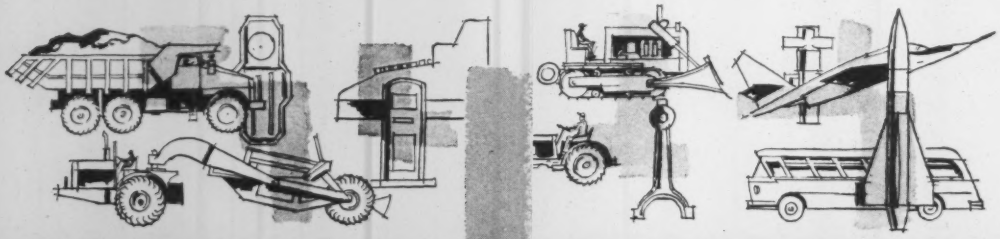
Address_____ City_____ State_____

USE T&W
Cost and Quality Research

When your requirements involve forgings or deep drawn stampings,—and if you are faced with the problem of *reducing cost and improving quality* take advantage of Transue & Williams *Cost and Quality Research*. There are excellent possibilities that our experience gained from producing a variety of forgings and stampings for many industries can be a valuable aid in helping you solve your forging and stamping parts problem. *Write or call us today or send us a print to learn how we can be helpful.*

Finding better ways to reduce cost and improve quality through experience.

Sales Offices: Philadelphia • Old Saybrook (Connecticut) • Chicago • Detroit • Dallas • Los Angeles



in forgings

Sizes: 1 ounce to 500 pounds

Materials: Carbon and Alloy Steel, Non Ferrous and Stainless, Titanium, Pure Molybdenum, and High Temperature Alloys (Plain or Heat Treated)

IT'S BETTER FORGED

in stampings

Sizes: 3 inches by 3 inches, to 60 inches long, 40 inches wide and 16 inches in drawn depth.

Materials: Steel, Stainless and Aluminum. (Blanking, forming, welding, sub and final assemblies).

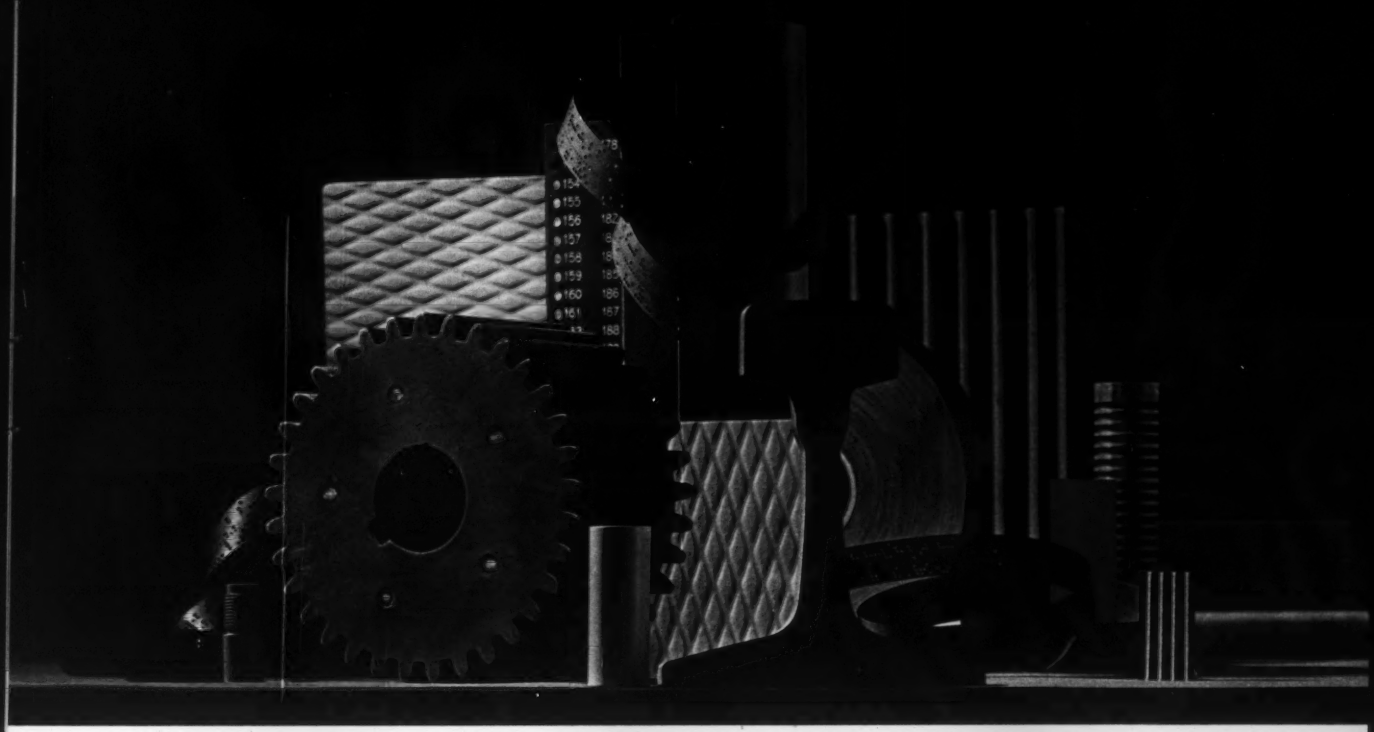
TRANSUE & WILLIAMS

ALLIANCE, OHIO

FORGINGS AND DEEP DRAWN STAMPINGS

For more information, turn to Reader Service card, circle No. 351

For more information, circle No. 416



THIS remarkable plastic may trigger a new (or cost-saving) design idea for you

National Vulcanized Fibre is unique. It's a tough, cellulosic plastic—not mere paper or fiberboard. Vulcanized Fibre possesses an unusual combination of mechanical, electrical and thermal properties. For example . . .

It weighs one-half as much as aluminum, yet is one of the strongest materials known per unit of weight. It's tough, durable and cushions the shock of repeated blows.

Vulcanized Fibre has superior arc-resistance. It comes in standard and special grades, including a fire-resistant grade called "Pyronil." It can be machined, formed or deep-drawn into intricate shapes, and can be combined with other materials . . . aluminum, rubber, "Mylar," copper, laminated plastic, plywood, to name a few.

You can polish it, paint it, lacquer it, emboss it. And regardless of the finish, it resists oils, gasoline, fungi, most solvents. Most surprising is its low cost.

Find out for yourself why National Vulcanized Fibre is "the plastic with a million uses." There's a free sample kit waiting for you at a nearby NVF sales office. Check Sweet's Product Design File 2b/Na for the one nearest you. Or write directly to Dept. PP, Wilmington, Delaware.

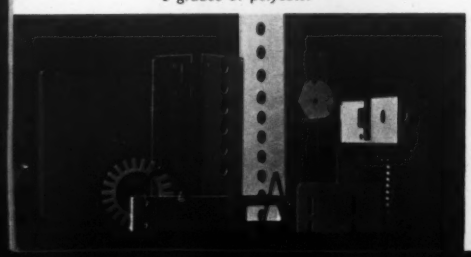
116 Choices: One Source This is the latest count of the different plastics and grades NVF can offer in your search for the *one best material.* Add to this total *the* one special grade that can be developed from scratch to meet your particular need. This full range of materials is backed by complete engineering services . . . from application assistance up to and including the delivery of 100% usable, precision-fabricated parts . . . in any quantity, on time!

Call the NVF Sales Office near you. It's a direct line to single-source help on your current materials problem.

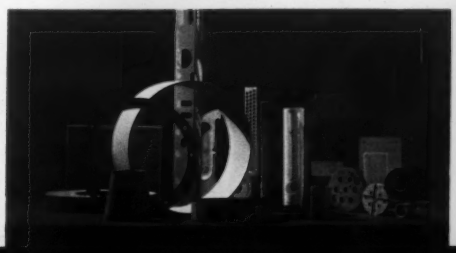
NVF

NATIONAL VULCANIZED FIBRE COMPANY
WILMINGTON 99, DELAWARE
In Canada: NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario

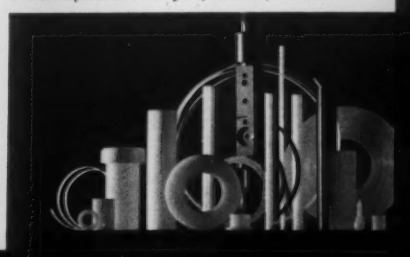
5 grades of polyester

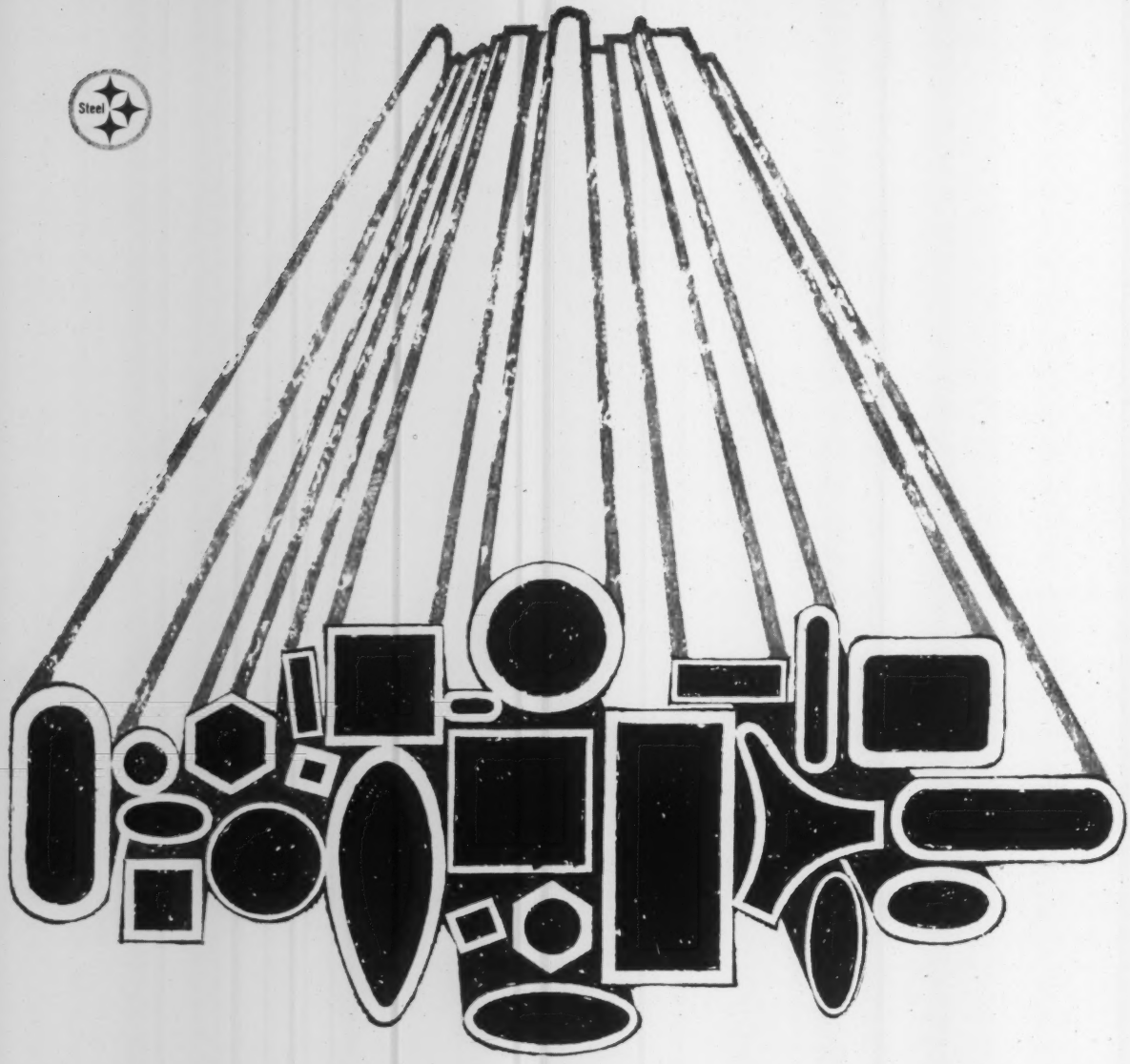


85 Phenolite® laminates



3 thermoplastics . . . nylon, Delrin®, Penton®





DESIGN WITH SAFETY...IN ALL SHAPES AND SIZES!

Armco Steel Corp. ↑
The Babcock & Wilcox Co., Tubular Products Div. ↑↓
The Carpenter Steel Co., Alloy Tube Div. ↓
Jones & Laughlin Steel Corp., Electricweld Tube Div. ↑
National Tube Div., United States Steel Corp. ↑
Ohio Seamless Tube Div., Copperweld Steel Co. ↑
Republic Steel Corp., Steel and Tubes Div. ↑↓
Revere Copper & Brass Inc., Rome Mfg. Co. Div. ↑↓
Sawhill Tubular Products, Inc. ↑↓
Southeastern Metals Co. ↑
The Standard Tube Co. ↑↓
Superior Tube Co. ↓
Trent Tube Co., Subs. Crucible Steel Co. of America ↓
Union Steel Corp. ↓
Van Huffel Tube Corp. ↑
Wall Tube & Metal Products Co. ↓
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↓ PRODUCES WELDED STAINLESS STEEL TUBE
↑ PRODUCES WELDED CARBON STEEL TUBE

Regardless of the shape or size, when you specify domestically-produced welded steel tubing, you are assuring uniformity. Wall thicknesses are uniform, concentricity exact. In a rotating part, the result is a better, safer, vibration-free operation. In other applications, the welded steel tube gives you the same design strength as bar stock, with less weight.

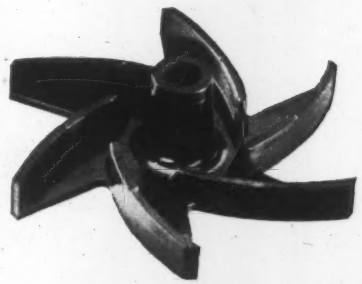
The quality producers at left are prepared to help you design with tubing in all weldable grades of carbon, stainless steel and other alloys. You can get useful information from any of them or you can write for your free Booklet 8591, Dept. MD-5, Welded Steel Tube Institute, Inc., Hanna Building, Cleveland 15, Ohio. It will pay in uniformity, safety, and savings in weight.

WELDED STEEL TUBE INSTITUTE, INC.

For more information, turn to Reader Service card, circle No. 358

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Phenolic for pumps**
- **Dip-coating compounds**
- **Plastic process equipment**



FLINT & WALLING MFG. CO., INC.

Why not?

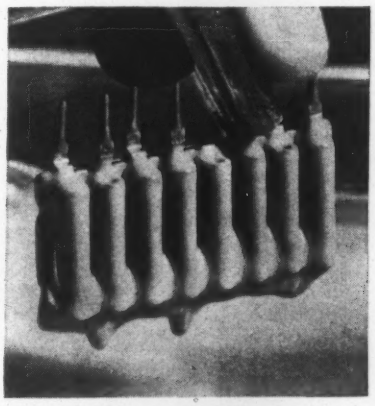
Here's a good way to engineer more profit into a pump.

The impeller is phenolic. It won't rust or corrode; it defies stubbornly the onslaughts of acid, oil, alkali, and soap.

A cubic inch of molded phenolic costs much less than you'd allow for a more traditional impeller material. Forget about machining; phenolic parts seldom need any.

If a pump must handle liquids as hot as 300°F, don't let that stop you from specifying phenolic.

We can work with your molder on the application you have in mind. Why not write us about it? Or simply check the coupon for Bulletin D400. It lists the properties of a typical Durez phenolic molding compound used in pumps, and includes much other useful information.



Coat for components

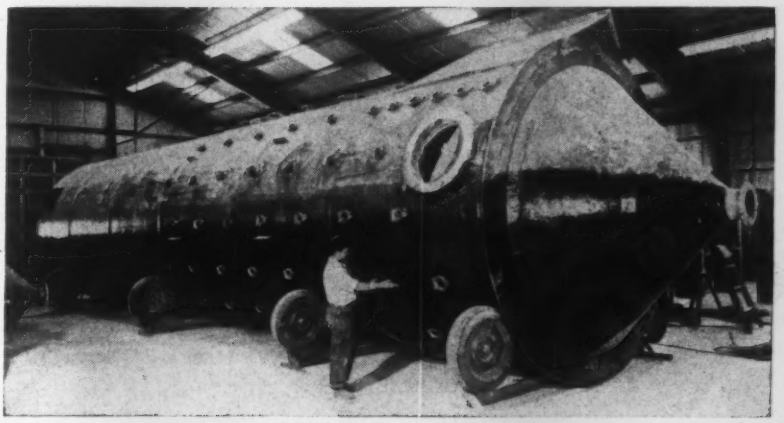
Looking for a simple encapsulating idea? Here's one that works well at heatproofing, moisture-proofing, and preventing shorts in small electrical components. It's non-messy, too.

Dunked in a paste coating, dried, then baked for a short time, components steadfastly resist extremes of heat and moisture that would otherwise raise havoc with their electrical reliability.

Components so coated can be soldered into a circuit without causing the coating to melt or peel. It won't soften, and easily passes a series of −55 to +85°C cycles. One thousand hours at a sweltering 150°C will turn the coating almost black but still won't materially affect the component inside.

The paste is made with Durez phenolic resin-and-filler compounds supplied in powder form. There's a choice of densities and toughnesses. One type is impervious to ketone solvent cements sometimes used in assembling radio and TV chassis.

What can these dip-coating compounds do for you? We'd like to help you find out. Write for more detailed information.



FABRICATOR: DU VERRE, INC., ARCADE, N.Y.

What's your big idea?

Think big. A 50-foot plastic boat . . . a 150-foot plastic radome . . . or a plastic chemical scrubber like this behemoth designed and sold by Buffalo Forge Co.—all are actualities today, with an assist from glass-reinforced Hetron® polyester resin.

The scrubber is expected to save someone a lot of money. In corrosive situations, Hetron has repeatedly proved it can outlast other commonly used materials by a factor of two, three, or more. First cost can be as low as one-third that of other special corrosion-resistant materials.

There's one other important point: safety. Hetron is inherently self-extinguishing. It retards fire because of its unique molecular configuration. Often, a Hetron installation—whether it's ducts, fume hoods, tanks, stacks, or blowers—can obviate the need for a sprinkler system.

If you'd like to know what the process-equipment fabricators are doing nowadays with this versatile, safe polyester, use the coupon. We'll gladly send you a data file on Hetron, including a list of leading fabricators who can shape it to your specifications.

For more information on Durez materials mentioned above, check here:

- ☐ Phenolic molding compounds (8-page Bulletin D400)
- ☐ "Phenolic Resin Compounds for Dip-Coating"
- ☐ Hetron polyester resin (data file and list of fabricators)
- ☐ "Durez Plastics News" (a review of current plastic applications, mailed bimonthly)

Check, clip and mail to us with your name, title, company address.

DUREZ PLASTICS DIVISION

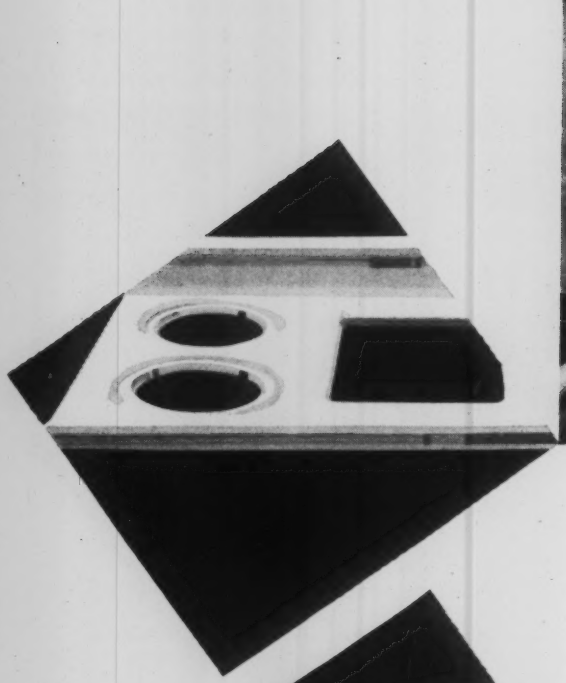
1410 WALCK ROAD, NORTH TONAWANDA, N. Y.

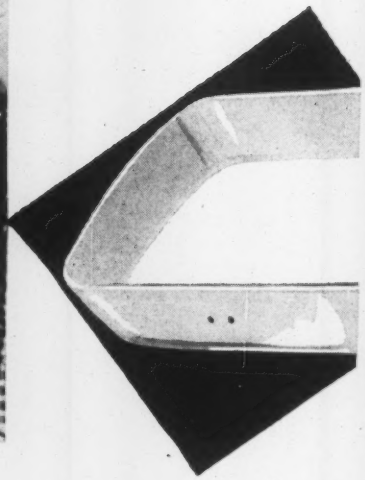
HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

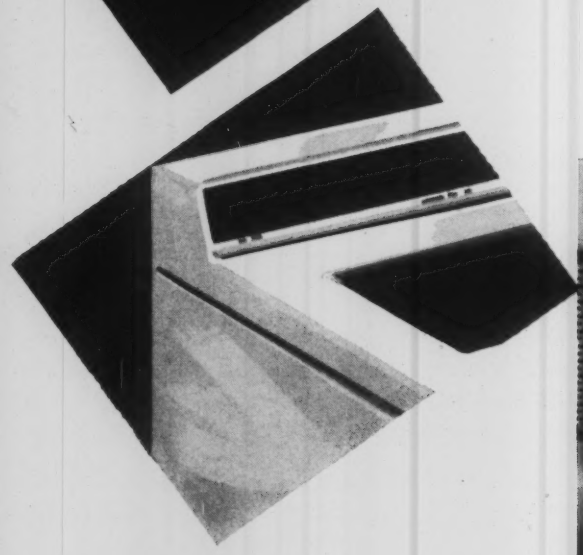
For more information, turn to Reader Service card, circle No. 384

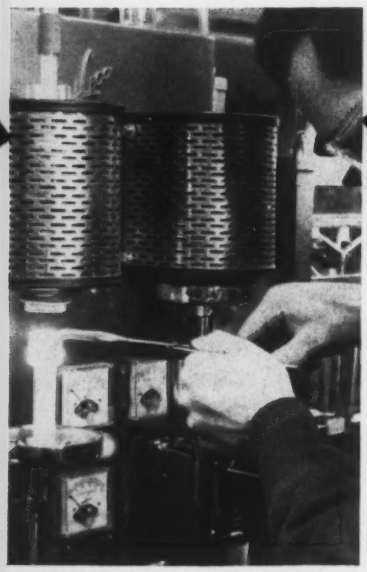
Proper grain size—vital to drawing properties—is checked microscopically before each lot of Armco Enameling Iron or UNIVIT is shipped.

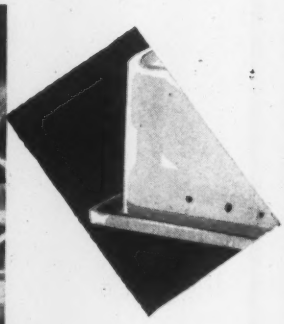




DESIGN FOR With



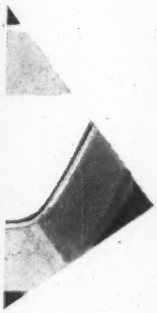




Armco UNIVIT is closely checked to assure virtual absence of carbon.

NEW STEELS ARE BORN AT ARMCO

Specify Armco UNIVIT for superior 1-coat, 1-fire porcelain enameling; Armco Enameling Iron for high quality 2-coat enameling



Armco UNIVIT® opens new vistas for product designers, permitting one-coat, one-fire porcelain enameling without danger of boiling or fishscaling. A porcelain enamel finish "direct-on" Armco UNIVIT fights abrasion and corrosion, provides exceptional resistance to mechanical damage and thermal shock. Cost? It compares favorably with baked enamel or vinyl finishes.

For color, form, durability

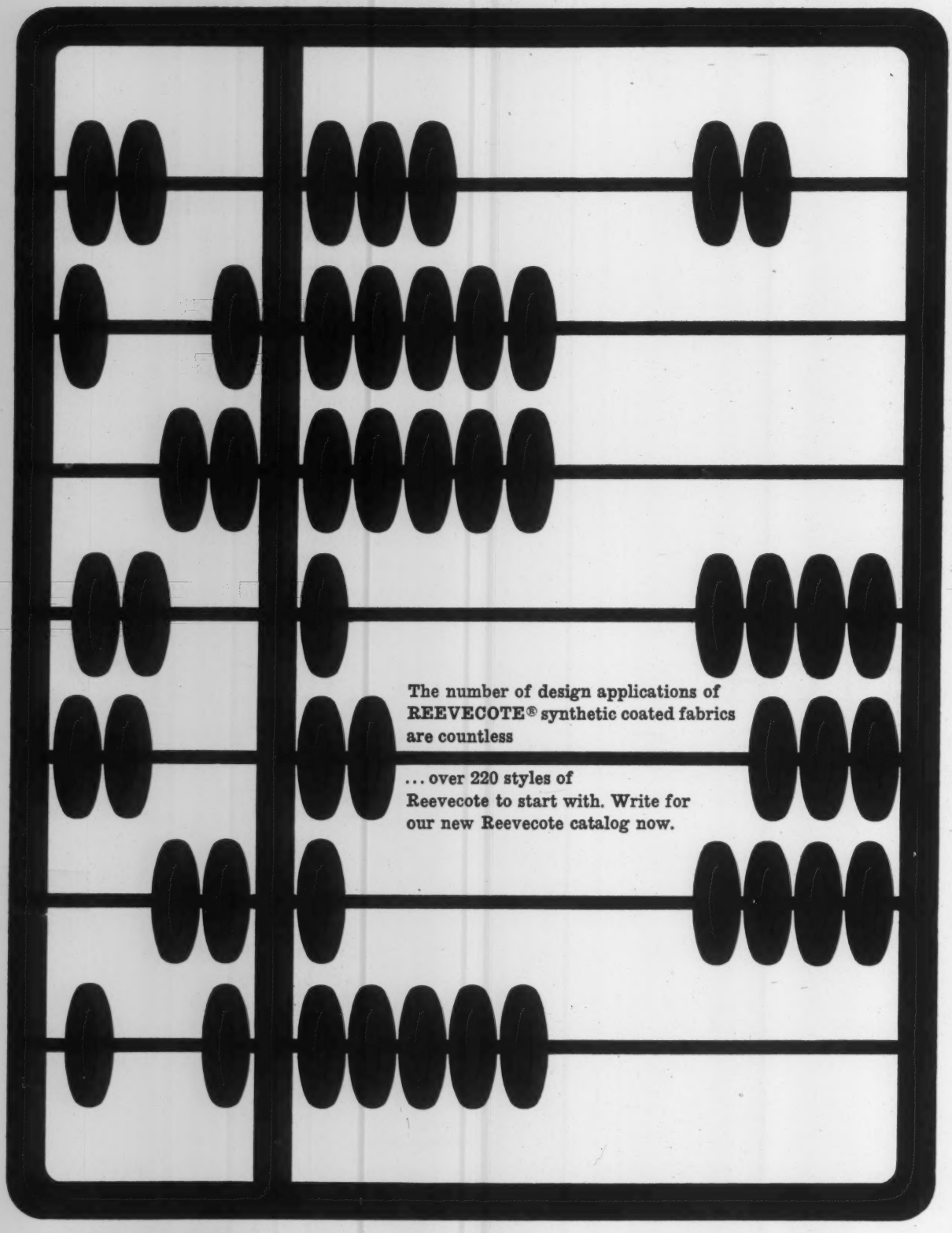
COLOR, FORM, DURABILITY
2 Armco Enameling Metals

For high-quality two-coat porcelain enameling, Armco Enameling Iron has long been noted for its excellent enameling properties, workability and freedom from sag in firing.

Together, Armco UNIVIT and Enameling Iron offer wide latitude for designers seeking to give their products the color, form and durability of porcelain enamel. For complete information, write **Armco Division, Armco Steel Corporation, 2021 Curtis Street, Middletown, Ohio.**

ARMCO **Armco Division**

For more information, turn to Reader Service card, circle No. 349

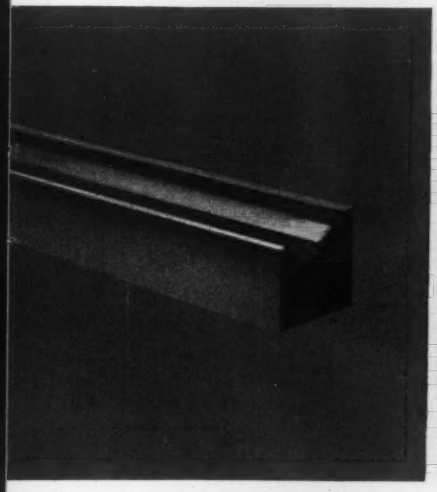

The number of design applications of
REEVECOTE® synthetic coated fabrics
are countless
... over 220 styles of
Reevecote to start with. Write for
our new Reevecote catalog now.

REEVES
VULCAN

Reeves Brothers, Inc., 1071 Avenue of the Americas, New York 18, New York

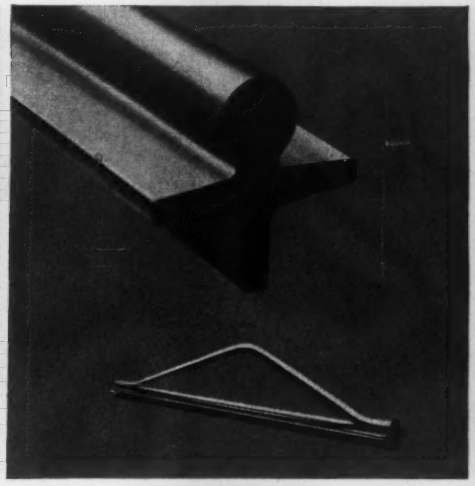
For more information, turn to Reader Service card, circle No. 323

How to cut costs to make a better product



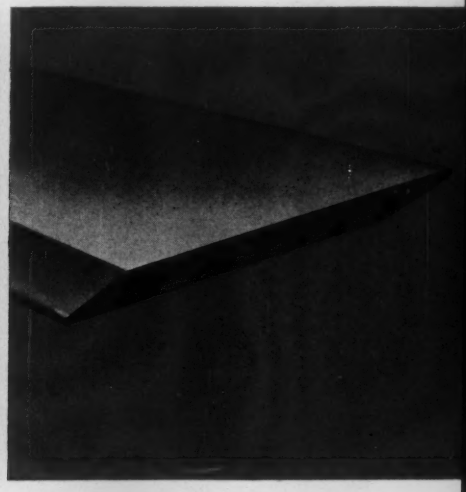
Costly machining eliminated

Manufacturer used to machine square stock to produce typewriter carriage rails. By changing to this special steel section, accurately hot-rolled and then cold-drawn to precise dimensions, he eliminated much costly machining, avoided scrap loss. Production rate was increased considerably.



For greater strength and durability

This custom-rolled section makes possible the economical fabrication of a railroad brake beam. Our customer first separates most of the "round" section from the "tee" by splitting the web between them to points near each end of the bar. He then compresses the "tee" portion of the bar, reducing its length and forcing the "round" outward to form a unitized truss. He reports this one-piece beam gives more reliable service, and is stronger than beams made by welding, bolting, or casting.



Faster production . . . using less steel

Our customer produced grader blades by flamecutting square-edge plate. By substituting this double-bevel special section, he eliminated the cutting operation, improving both his production rate and the appearance of his product. Because less steel is needed, the section costs less per foot, and shipping costs are reduced.

DESIGN WITH SPECIAL BAR SECTIONS, HOT-ROLLED TO YOUR SPECIFICATIONS

When you use special sections you buy less steel. You generate less scrap. Shipping and handling costs go down. Special sections reduce machining and fabricating operations and cut production costs. Special sections provide more freedom of design, and a stronger, more durable product—a product that has more sales appeal.

Could you use special bar sections, hot-rolled to your own product specifications? We'd be happy to discuss the possibilities with you . . . just call or write the Bethlehem sales office nearest you.

Steel *for Strength . . . Economy . . . Versatility*

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Sales:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, turn to Reader Service card, circle No. 380

NEWS FROM GOODRICH-GULF

NEW SYNTHETIC RUBBER CAN REPLACE NATURAL 100% IN HEAVY DUTY TIRES

Goodrich-Gulf is now proceeding with a multi-million dollar plant for the commercial production of Ameripol CB (cis-polybutadiene) rubber. CB is the only known polybutadiene rubber which can be used as a 100% replacement for natural rubber in heavy duty tire treads.

In over 5 million miles of test driving on Ameripol CB tire treads, up to double the tread life of natural rubber has been achieved. Superiority is greatest in very severe conditions including heavy loading, long distances, and high-speed turnpike driving.

The first Goodrich-Gulf plant unit will produce at an annual rate of 20 million pounds. In addition, other companies will produce CB under license.

Ameripol CB has qualities which may be advantageous in applications beyond tires. Good electrical properties, abrasion resistance can provide superior coverings for electrical wires that are subjected to mechanical wear. Outstanding flex properties suggest superior performance in power transmission belting and conveyor belting.

This new development complements Goodrich-Gulf's production of Styrene-Butadiene Rubber (SBR) in non-pigmented hot, cold, and oil-extended types; and micro-black masterbatch cold, and cold oil-extended types.

Ameripol
THE PREFERRED RUBBER

PROCESSING COSTS CUT WITH NEW MEDIUM-LOW VISCOSITY SBR

Newest addition to the Ameripol SBR family, Ameripol 4604, has the combined features of a high bound styrene with a minimum-low raw Mooney viscosity in the range of 30 to 42.

The high bound styrene content, together with medium-low viscosity, results in a cold polymer with excellent processing characteristics. Time is saved, and need for peptizing agents is eliminated.

TYPICAL PHYSICAL PROPERTIES

(Based on test recipe of 100.0 parts Ameripol 4604, 40.0 parts EPC Black, 5.0 parts zinc oxide, 1.5 parts stearic acid, 2.0 parts Benzothiazyldisulfide, 2.0 parts sulfur).

Raw Viscosity, ML-4 @ 212°F.		40
Compound Viscosity, ML-4 @ 212°F.		51
	Cure @ 292°F.	
Tensile, psi	50′	3080
Elongation, %	50′	745
Modulus, 300%, psi	25′	310
300%, psi	50′	830
300%, psi	100′	1260

Light color, low viscosity, outstanding physical properties, and low water absorption qualify Ameripol 4604 for products such as:

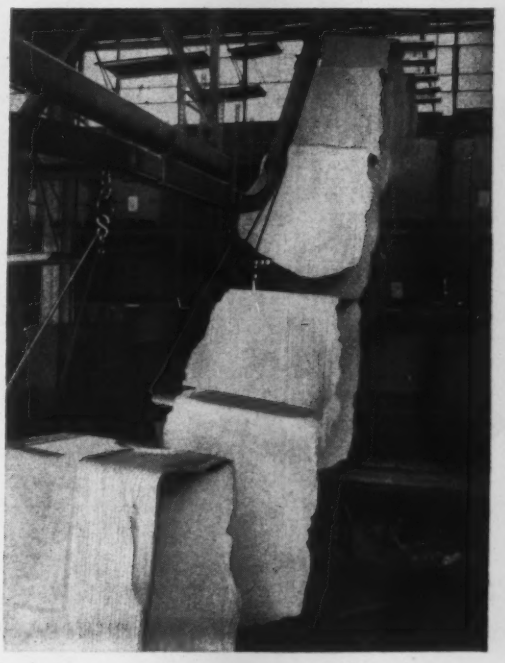
Closed Cell Sponge • Calendered Goods • Open Cell Sponge • Transfer Molded Items • Cements • Coated Fabrics • Adhesives • Hard Rubber

AMERIPOL 4700 CUTS FLOOR MAT COST

Each one of these automobile floor mats coming down the conveyor line at Anchor Industries, Inc., Cleveland, represents a savings over the previous rubber polymer used.

The mats are made from Ameripol 4700, which is a 50-part oil-extended rubber; thus costs substantially less than low-oil polymers. Ameripol 4700 maintains the high quality level this company has established; permits processing in a range of colors.

Since Goodrich-Gulf produces the broadest range of SBR polymers, we are in excellent position to help you in selecting the type which exactly meets your needs.

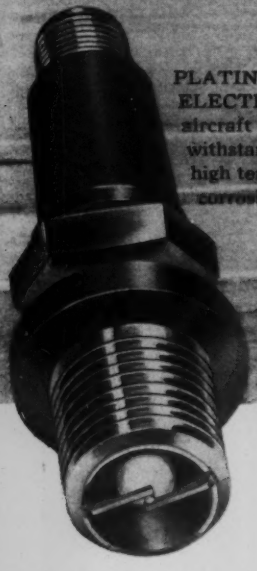


For information, write: 1717 East Ninth Street, Cleveland 14, Ohio

Goodrich-Gulf Chemicals, Inc.

WORLD'S LARGEST SOURCE OF SYNTHETIC RUBBER

For more information, turn to Reader Service card, circle No. 390



PLATINUM METAL ALLOY ELECTRODES are used in aircraft spark plugs to withstand extremely high temperatures and corrosive combustion gases.

Where no metal but Platinum

Electrodes made of Platinum metal alloy deliver longer, trouble-free service in aircraft spark plugs

A spark plug fires an average of 1100 times per minute at cruising speed in a piston-engine airliner. With each vital spark, the ignited gasoline in the engine's combustion chamber heats the electrodes to high temperatures.

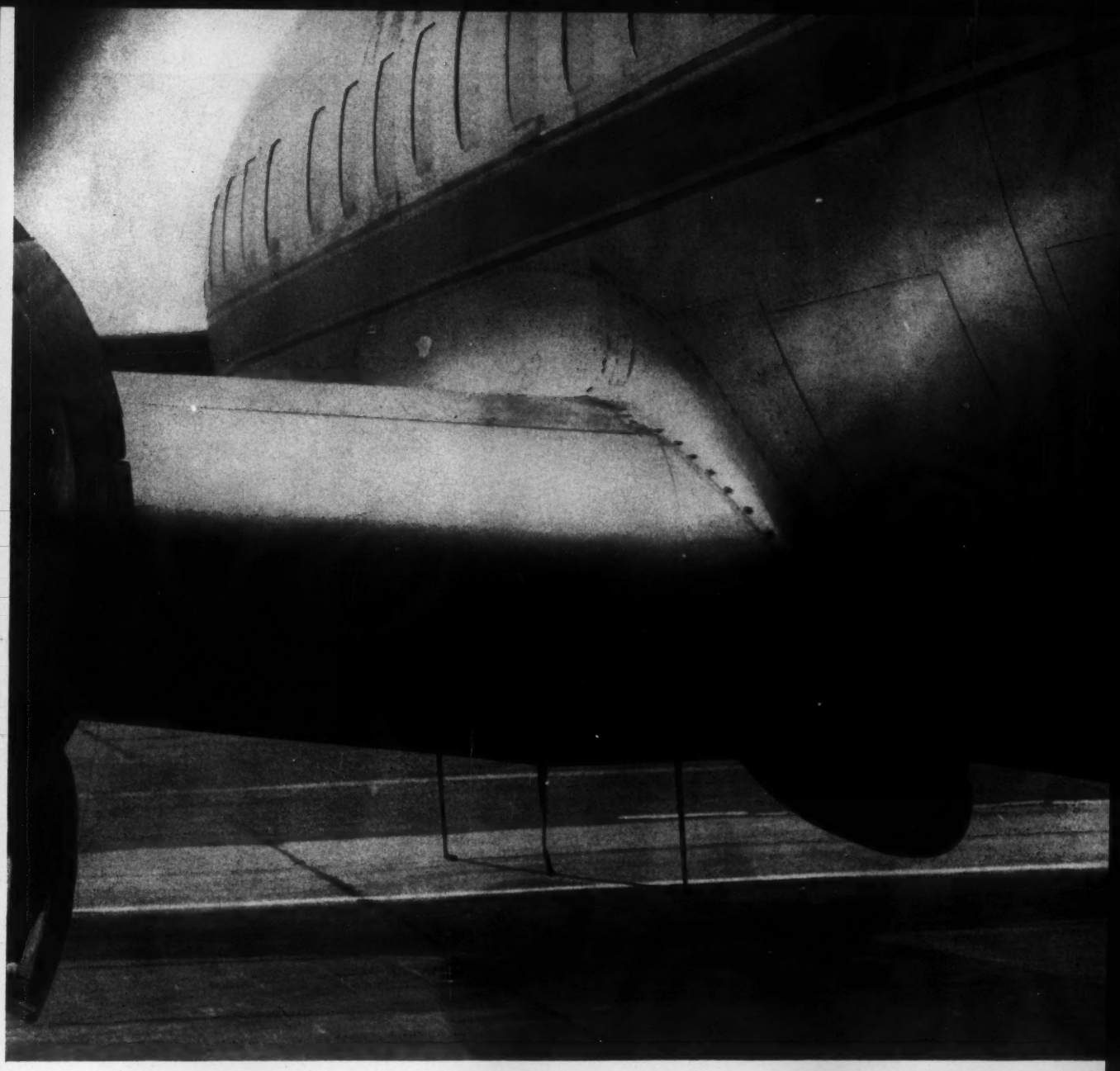
To withstand the rapid, repeated heating and cooling with every cycle of the engine—and to resist electrical erosion, and corrosion by lead-containing fuels—spark plug manufacturers make electrodes of a *Platinum* metal alloy.

This critical application dramatizes one vital fact: the dependability of Platinum. No metal but *Platinum* will do the job as well.

It could pay you to use a Platinum Metal

Your problem might be readily and economically solved with Platinum Metals—where high temperature corrosion and spark erosion are involved, such as in aircraft spark plugs . . . where reliable make-and-break electrical contact is indicated, such as in low noise high fidelity transmission . . . where wear-resisting, non-tarnishing surfaces are required, such as for printed electrical circuits . . . where a combination of severe corrosion and erosion must be met, as in the case of spinnerettes for rayon production . . . where peak catalytic efficiency is required, as in the refining of high octane gasoline . . . or where product purity must be retained despite high temperatures, as in the case of lens glasses . . . the Platinum Metals have proved to be the most economical for certain critical equipment.

Industry is going to higher temperatures and higher pressures.



will do the job as well...

Perhaps your own progress has been blocked by the limitations of materials to withstand such severe conditions. The Platinum Metals have removed many barriers. Have you considered them for your problems?

Platinum, palladium, rhodium, ruthenium and iridium have unique potentials, well worth your attention. Specialists are prepared to work closely with you in evaluating these metals for new commercial and scientific uses.

As a first step, write us for additional data on the outstanding characteristics and successful applications of the six Platinum Metals and their alloys—indicating your field of interest or how we might be of assistance.

CAN THESE PROPERTIES OF THE PLATINUM METALS HELP YOU?
High Temperature Stability
Exceptional Chemical Inertness
Superior Wear Resistance
Peak Catalytic Activity
Low Vapor Pressure

The six Platinum Metals are:

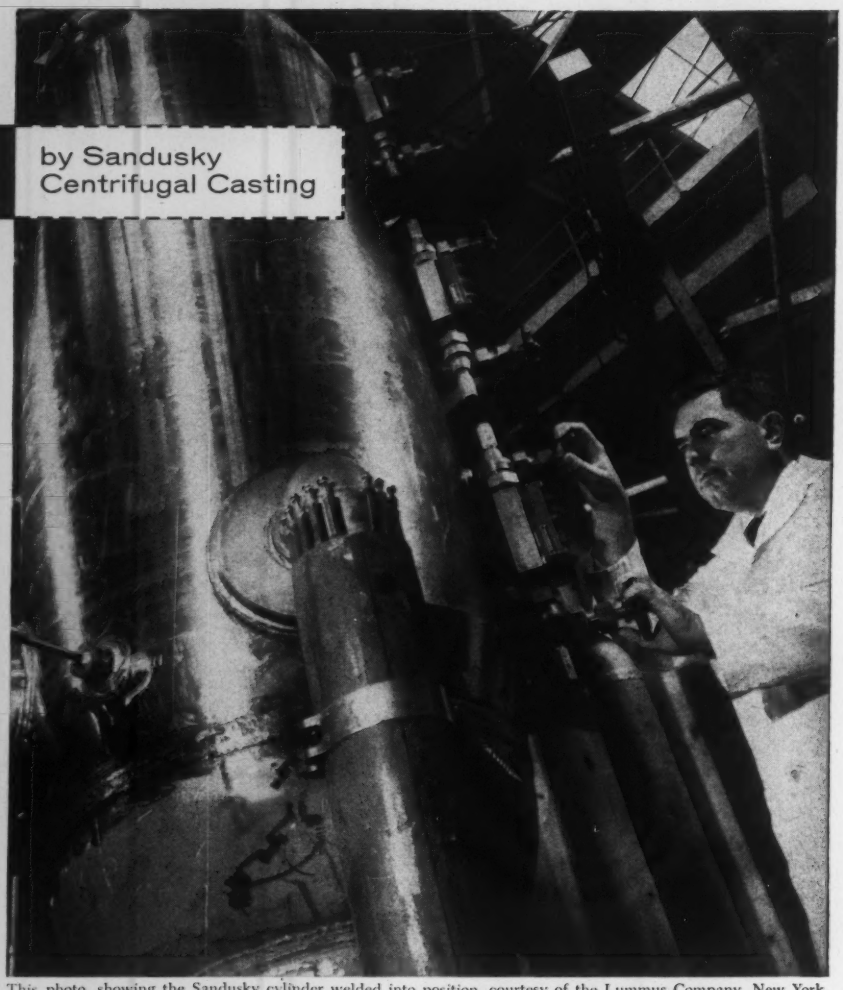
PLATINUM · PALLADIUM · RHODIUM
RUTHENIUM · IRIDIUM · OSMIUM

INCO TRADE MARK

PLATINUM METALS DIVISION, The International Nickel Company, Inc., 67 Wall Street, New York 5, N.Y.

For more information, turn to Reader Service card, circle No. 328

SOLVED: by Sandusky Centrifugal Casting



This photo, showing the Sandusky cylinder welded into position, courtesy of the Lummus Company, New York. New York who fabricated, assembled and tested the completed loop before shipping it to the ETR site in Idaho.

Nuclear Test Loop Uses Sandusky Centrifugal Casting as Pressurizer Cylinder

A Sandusky Centrifugal Casting is the main eylindrical component of an electrically heated pressurizer, designed by Knolls Atomic Power Laboratory to Section VIII, of the ASME Code (Unfired Pressure Vessels) for use in the new Engineering Test Reactor facilities at Idaho Falls, Idaho.

This 66¼" long cylinder, 27" O.D. with walls 2½" thick, was centrifugally cast of an 18-8 stainless steel (SA-351, Grade CF-8) for the extra corrosion resistance required under nuclear loop service conditions: demineralized water at temperatures to 650°F and pressures to 2500 PSI.

O. G. Kelley Co., Boston, to whom we delivered this 2-ton, fully machined cylinder, welded on the forged heads and nozzles, radiographed the welds, and hydro tested the completed vessel to 4300 PSI.

This is another example of the adaptability of Sandusky Centrifugal Castings to applications demanding the highest order of quality. They may well offer you a practical and economical answer to your cylindrical needs, also.

We are producing cylinders and piping in diameters from 7" to 54"—in lengths to 33 ft.—in a wide range of ferrous and non-ferrous alloys. Write for Bulletin 300, for more complete technical information on the Sandusky process and product application data.

SANDUSKY CENTRIFUGAL CASTINGS

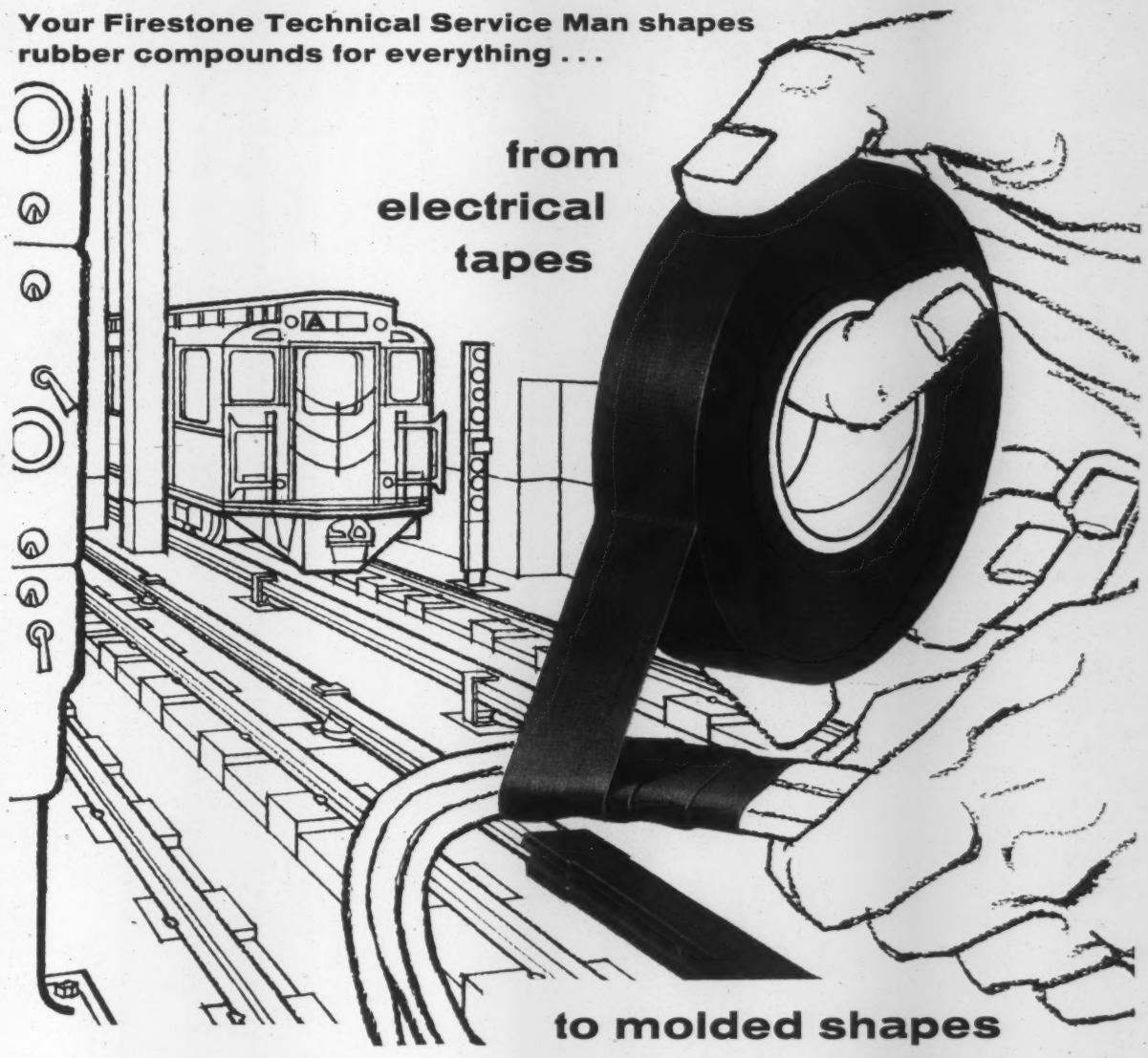
FOUNDRY & MACHINE CO.

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

9903

For more information, turn to Reader Service card, circle No. 368

Your Firestone Technical Service Man shapes rubber compounds for everything . . .



Need an electrical tape that won't crack or curl in cold? Or molded "third rail" guards to isolate high voltage? Your Firestone Technical Service Man can supply the answers—and he has solutions for thousands of other design problems involving rubber, too. He'll create compounds that defy solvents, oils and acids, stand up to wear and abrasion longer and resist aging. Your Technical Service Man can engineer compounds that combine these and many other qualities, even devise rubber that replaces more expensive materials you may be using in your product now. And he can put Firestone's fabricating facilities to work to carry the job through—in the volume you want, at a price to fit tight budgets. More information? Simply fill out and mail the coupon—without obligation, of course.

Copyright 1961, The Firestone Tire & Rubber Company

Firestone

Rubber & Latex Products Company

Fall River, Massachusetts

WITHOUT OBLIGATION, WE'D LIKE TO FIND OUT WHAT FIRESTONE'S TECHNICAL SERVICE MAN HAS TO OFFER US.

FMR-FR31(3)

Name and Title

Company

Product Manufactured

Address

City

State

FIRESTONE
RUBBER & LATEX
PRODUCTS CO.
Box 2290, Fall River, Mass.

For more information, turn to Reader Service card, circle No. 408

Chrome
Plated
Steel

This mark tells you a product is made of modern, dependable Steel.

How a "specially tailored" strip reduces production rejects almost 25% for Kromex

Kromex, Inc., Cleveland, Ohio, turns out a complete line of pantry ware, but they were having trouble with a square, mirror-finish chromium-plated cake cover that was made with a single deep draw. Rejection rate was a stunning 25%. They first tried a No. 3 finish for this application, but because of the very deep draw and the dense and smooth surface, satisfactory lubrication was near impossible. The result: Excessive draw marks and breakage. A regular No. 2 finish was then tried. The draw was successful. But buffing and finishing costs were prohibitive for this application.

American Steel and Wire salesmen conferred with our Metallurgical Department and suggested a specially tailored No. 3 finish. Reject rate dropped to less than 1% because the special surface was able to hold lubricant evenly, but smooth enough to draw and plate flawlessly.

Kromex is one more example of how strip, *tailored to end use,* works to produce a better product at lower cost. When you buy strip, you're buying a specific chemistry, temper, dimension, edge and finish that is consistently uniform within the coil or from coil to coil. Certain of your processing steps may actually be eliminated by using cold rolled strip, produced in our mills, and tailor-made for your specific end use.

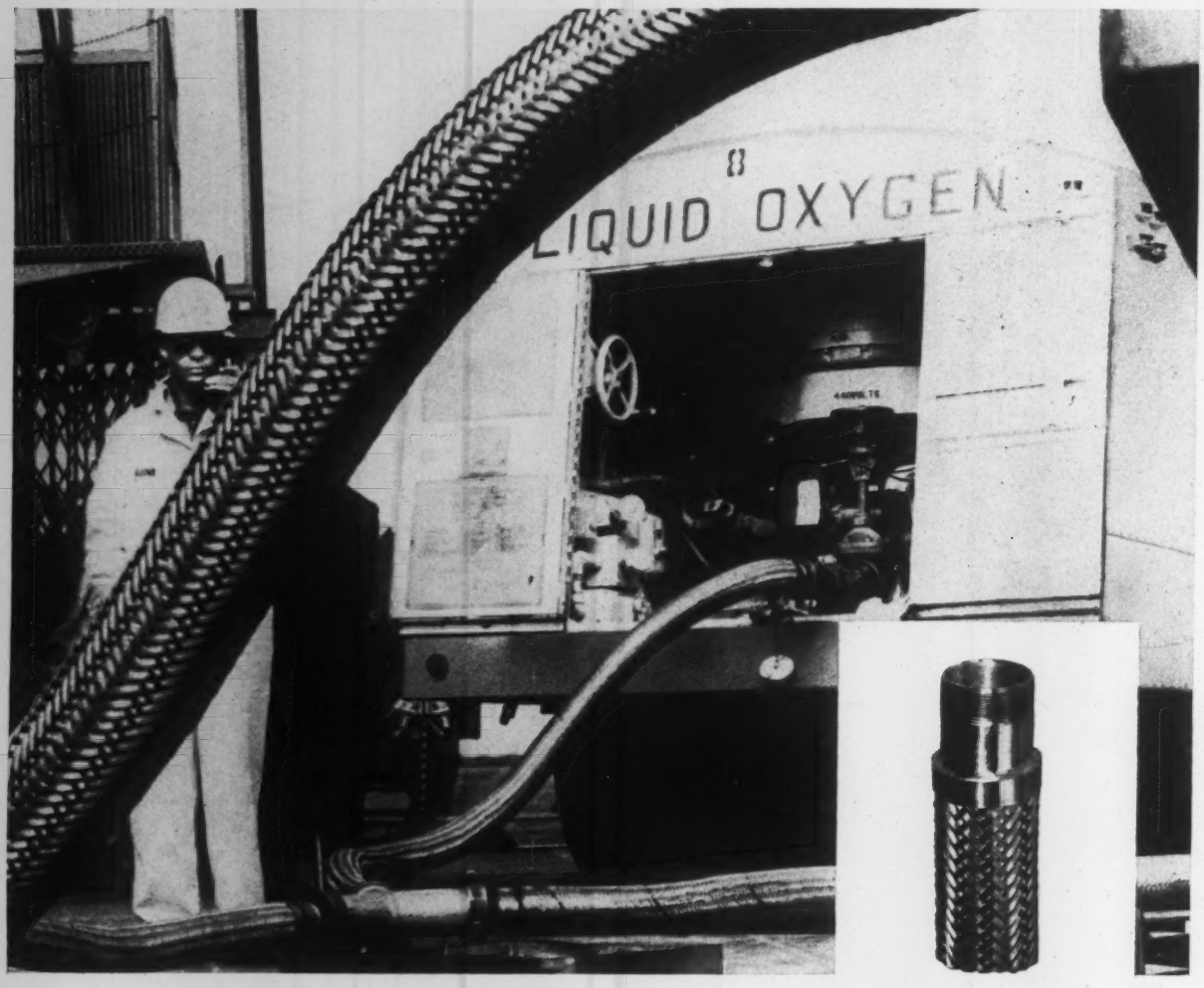
Take a hard look at your production line and let our salesmen and metallurgical people look too. There's a good chance you can improve quality and cut production costs at the same time with *tailored-to-the-job* cold rolled strip from American Steel and Wire. American Steel and Wire Division, Rockefeller Bldg., Cleveland 13, Ohio. *USS and American are registered trademarks.*

USS American Steel and Wire Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
Tennessee Coal & Iron Division, Fairfield, Alabama, Southern Distributors
United States Steel Export Company, Distributors Abroad

For more information, circle No. 445

3½ inch I.D. Anaconda flexible metal hose lines are shown here transferring liquid oxygen to Army missile. Brazed metal hose-to-fitting connections are made with Handy & Harman brazing alloys.



Handy & Harman Brazed Connections Withstand Thermal Shock From Liquid Oxygen . . . Time After Time

It is hard to think of a single more punishing test for a metal joint than the nearly instantaneous plunge from approximately 100° F to —297.4° F experienced by these brazed metal hose connections. Yet they take it time and again — and come back for more.

This is part of an assembly employing Type 321 stainless steel flexible hose made by Anaconda Metal Hose to transfer liquid oxygen to Jupiter missiles at the Redstone Arsenal. Fittings are stainless steel, integrally bonded to the hose by Handy & Harman brazing alloys—EASY-FLO and EASY-FLO 35 with Handy Flux. The reasons for using Handy & Harman brazing alloys here make good fabricating sense no matter what the job. First, they provide strong, integral joints that remain strong, ductile and resistant to vibration and shock even to liquid oxygen temperatures and pressures where many metals become brittle. Secondly, they allowed Anaconda to increase burst pressure limits since there is no annealing of the base metal. In addition, they make it possible for Anaconda to perform joining operations with less equipment and less expense in manpower than would otherwise be necessary.

This is only one example of many applications of Handy & Harman brazing products in cryogenics and other fields of engineering to solve critical bonding problems which achieve fast production and operating economies. There's a good chance they will do the same for you. Call or write for further information on how to apply brazing techniques to solve your fabricating problems.

Our Bulletin 20 contains a wealth of data on silver brazing, its range of applications and techniques for securing best results. Write today for your copy.

Your No. 1 Source of Supply and Authority on Precious Metal Alloys

HANDY & HARMAN
850 Third Ave. New York 22, N. Y.

For more information, turn to Reader Service card, circle No. 401

Thickness control of anodic and other nonconductive coatings on aluminum may be aided by the use of a new portable thickness gage, claimed to have a unique feature. The instrument, operating on eddy currents, contains electronic circuitry which is said to compensate for conductivity variations that would otherwise produce erroneous readings.

Source: Twin City Testing Corp., 533 S. Niagara St., Tonawanda, N. Y.

A leaded vinyl-coated fabric reduces noise in helicopters as much as 4 db in the 20 to 75 cps range and 25 db in the 4800 to 9600 cps range, according to recent tests. Called Coustifab, the material consists of glass fabric to reduce sound reflection and a layer of vinyl containing fine lead particles to reduce sound transmission.

Source: Cordo Chemical Co., Norwalk, Conn.

Circular metal seals with an X-shaped cross section are being produced for extreme pressure and temperature service. The seals are said to be effective from —400 to 1500 F and from spatial vacuums to 6000 psi. Static and dynamic types are made of aluminum alloys, stainless steels and Inconel X to suit different requirements, in sizes from 3/8 in. to nearly 12 in. dia.

Source: Lockheed-California Co., Burbank, Calif.

Foam polystyrene provides cushioning and insulation for shells during transportation. It is used in carrying cases for the explosive spotting shells used with the Davy Crockett rocket launcher. In addition to its high rate of energy absorption, the foam has good thermal insulating qualities, is light in weight and low in cost.

Source: Armstrong Cork Co., Lancaster, Pa.

A new surface carburization technique shapes electron beams being emitted from cathodes, and suppresses emission from cathode supports and auxiliary electrodes. After masking the cathode areas that are intended for emission, exposed surfaces are carburized with tungsten and molybdenum carbides which will suppress emission. With this technique, cathodes having beam focusing or guard electrodes are said to be producible as a single structure.

Source: Phillips Electronic Instruments, 750 So. Fulton Ave., Mount Vernon, N. Y.

A film of gold on Teflon bladders for rocket fuel systems appears to be a promising barrier against seepage of high energy fuels. Chemically depositing a flexible 1-mil film reduces permeability 10 to 1000 times.

Source: Quantum, Inc., Lufbery Ave., Wallingford, Conn.

Research into the atomic structure of crystals can be accelerated using a new x-ray diffraction technique that is almost entirely automatic. Over 17,000 readings a day are said to be possible with Pexrad, a system that uses a high speed digital computer and a special type of diffractometer. The computer generates continuous signals for positioning the crystal to a hundredth of a degree accuracy, receives diffraction measurement information, and translates this into a form that is convenient for analysis.

Source: Bell Telephone Laboratories, 463 West St., New York 14, N. Y.

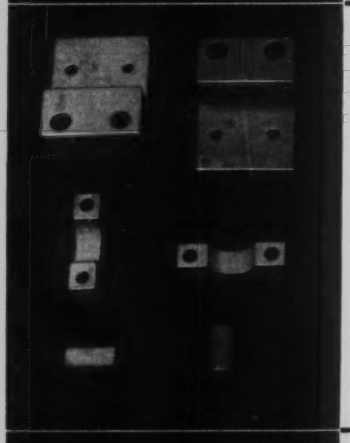
BERYLLIUM

PRODUCTS THAT REMOVE DESIGN BARRIERS, BACKED BY INDUSTRY'S FINEST TECHNICAL ADVISORY SERVICE

BERYLLIUM COPPER. BERYLCO alloys extend the performance possibilities of metal parts. Available in easy-to-fabricate strip, wire, rod, billets, forgings, castings, casting ingots, and master alloys.

Typical Properties

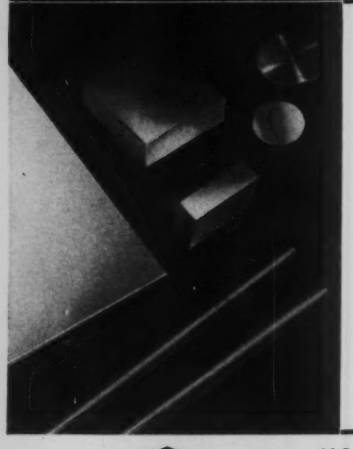
Ultimate Tensile Strength	up to 200,000 psi
Hardness	up to Rockwell C45
Non-Magnetic	permeability of 1.002 max.
Modulus of Elasticity	19,000,000 psi
Endurance Strength	45,000 psi
Electrical and Thermal Conductivity	up to 55% IACS
Age Hardenable	Can be worked soft, and precipitation hardened for maximum properties
Resists anelastic behavior	



BERYLLIUM OXIDE. This high temperature material is making possible new advances in nuclear, electronic, and the aircraft/missile fields. Its high dielectric strength, good electrical resistance, high thermal conductivity, and low neutron cross section give BERYLCO beryllium oxide a valuable "blend" of performance characteristics.

Typical Properties

Specific Gravity	3.008
Maximum Use Temperature	4000°F
Modulus of Rupture @ 70°F	26,000 psi
Thermal Conductivity, $\frac{\text{BTU-inch}}{\text{HR} \times \text{SQ. FT.} \times °\text{F}}$	
@ 70°F	1885
@ 392°F	1105
Electrical Volume Resistivity, Ohm-inch	
@ 70°F	1×10^{13}
@ 392°F	1×10^{12}
Loss Factor @ 1 mc	0.0008
Dielectric Strength	≧250 v/mil
Thermal Neutron Absorption Cross Section	0.00074 cm^2/cm^3



BERYLLIUM METAL. Structurals and components of BERYLCO beryllium are now doing key jobs that could never be performed before. Its unusual combination of properties is earning for beryllium an increasing importance in a wide range of applications. Available in sheet, rod, block extrusions and forgings.

Typical Properties

Melting Point	1285°C (2345°F)
Density (gm/cc)	1.85 (.066 lb./in.³)
Elastic Modulus, psi	42,000,000
Ultimate Tensile Strength, psi	40,000 hot pressed 70,000 extruded
Yield Strength, psi	30,000 hot pressed 45,000 extruded

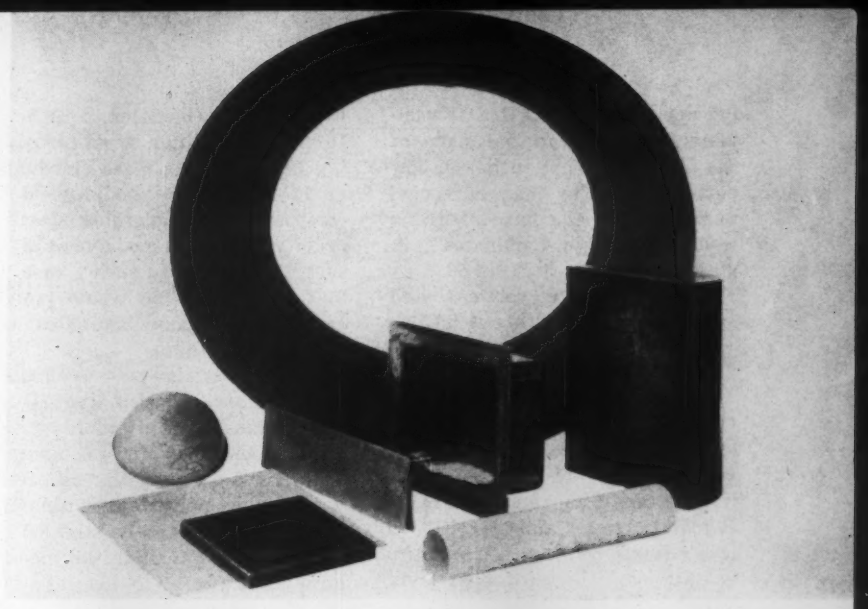
ALSO AVAILABLE: Beryllium Nickel, Beryllium Aluminum, Beryllium Magnesium, Ferro-Beryllium

BERYLCO®

THE BERYLLIUM CORPORATION

Reading, Pennsylvania

For more information, turn to Reader Service card, circle No. 411



***Large laminates** can be produced. Doughnut shown is 4 ft in dia by 1 in. thick.*

Flake glass reinforcement gives . . .

Stiffer Reinforced Plastics

***by L. P. Suffredini,** Chief, Materials Application and Process Development, Narmco Research and Development Div., Narmco Industries Inc., sub. of Telecomputing Corp.*

■ After several years of development, flake glass reinforcement has matured to the point where it may be considered a complement to fibrous glass reinforcement. In contrast to fibrous reinforcement it offers:

1. *Greater rigidity and strength* — Since flakes pack better than fiber mat or fabrics, higher proportions of glass can be incorporated, resulting in a composite more closely approaching the physical characteristics of the glass, rather than those of the weaker bonding agent.

2. *Strength is isotropic*—Flake is isotropic in strength in its plane, as opposed to the directional nature of strength in fibers or fabrics.

3. *Low moisture absorption* — The tortuous path presented by a high percentage of tiny glass platelets results in extremely low moisture absorption (e.g., 0.01% moisture pickup after 2-hr water boil), and low gas permeability.

4. *Excellent dielectrics* — Electrical integrity of the thin discrete glass films contributes to exceptional dielectric strengths.

5. *Lower cost*—Potentially lower in cost than fibrous reinforcements, flake also permits use of fabricating techniques more economical than conventional low pressure methods.

On the other hand, because flake is discontinuous it does not offer the tensile strength of continuous fiber reinforcement, and probably will never do so. Also, some of these benefits must still be labeled "potential." For example, lower cost will be realized only by development of commercial applications making proper use of the material's unique characteristics. Most important, a simple molding technique must be developed, such as extrusion. Another limitation is the additional development work needed to further improve the flake itself so that it can provide reinforcement of optimum efficiency.

Many resins evaluated

Over the years the whole spectrum of thermosetting resins and a variety of thermoplastic resins have been evaluated. Thermosetting materials have included the epoxies, polyesters, phenolics, melamines and alkyds. Thermoplastic materials have included polyethylene, vinyls and polyamides. Current work at various facilities is also being carried out on polycarbonates and acrylics.

Work at Narmco has been concentrated on developing maximum mechanical and electrical properties. Resin requirements for maximum strength include: 1) no volatiles formed during cure, 2) low shrinkage during cure, and 3) good wetting ability on unfinished glass surfaces.

An experimental Narmco epoxy resin designated X270 meets these requirements and has produced its best mechanical properties when compounded with 10 to 18 mesh E glass flakes 2μ in thickness (Owens-Corning's Filmglas). Laminates up to ¼ in. in thickness are made by compression molding at 800 psi and curing for ½ hr at 350 F. Molding arranges the platelets of glass parallel to direction of flow, forming a high-

ly oriented composite that is completely isotropic in the plane of the flake. Interruption in the flow pattern caused by changes in contour disorient the flake resulting in lower strength. Laminates have glass contents as high as 80% by weight (69% by volume) and specific gravities of about 2.15.

Mechanical properties compared

Table 1 compares properties of two types of flake-reinforced epoxy laminates with requirements for MIL-M-14E thermosetting molding compounds, and MIL-R-7575 polyester and MIL-R-9300 epoxy fabric-reinforced laminates.

Data on flake-reinforced laminate labeled NRC 1174/3 were reported by us in 1959; data on laminates labeled X270 are more recent and represent a substantial improvement in strength.

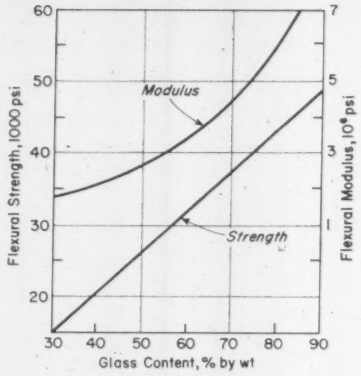
Note that results compare favorably with the MIL requirements for molding compounds and laminates; the only exception is in tensile strength where requirements for cloth laminates exceed the strength of flake. However, the flake laminates are isotropic, whereas the fabric-reinforced laminates are bidirectional. Thus, in certain geometries where uniform biaxial stresses are developed, flake laminates compare still more favorably with cloth laminates.

Effects of varying glass flake content on flexural strength and flexural modulus are indicated in data from Picatinny Arsenal shown in Fig 1. Note that the curves appear to confirm our data at 80% glass content.

The high modulus and low specific gravity result in exceptional strength-weight ratios. Weight-strength analyses comparing flake laminates with steel and aluminum in flat plates in compression and thin walled cylinders in compression are shown in Fig 2 and 3.

Of course, a comparison on the same basis with magnesium or beryllium alloys would be less favorable to the flake laminate. On the other hand, the full potential of flake laminates has not been attained yet. Substituting for the E-glass flake (modulus of 10.5×10^6 psi) a beryllium oxide-containing high modulus glass (modulus of 17×10^6 psi) should yield a composite of comparable specific gravity but with a modulus as high as 10×10^6 psi. In such a case, a 30% weight saving would result from using flake laminates in place of aluminum.

Fatigue resistance — Although fatigue data are still limited on flake-laminates, a preliminary SN curve is shown in Fig 4 compared with curves for cloth-reinforced epoxy and polyester laminates. Flake laminates can be stressed to almost 50% of their initial tensile strength after 10^7 cycles of com-



1—*Effect of glass content on flexural strength and modulus.*
(Picatinny Arsenal)

TABLE 1—PROPERTIES OF FLAKE GLASS-EPOXY LAMINATES

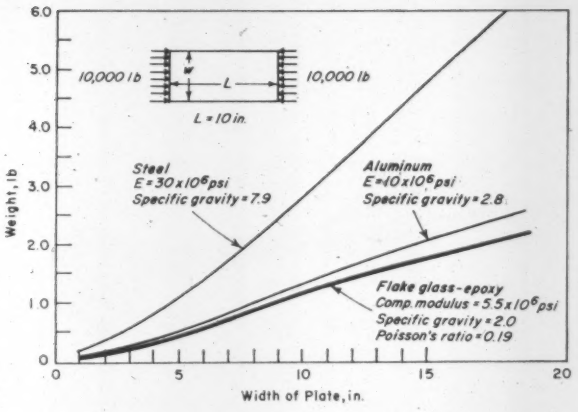
Property	L-P-406b Test Method	Flake Laminates		Military Specification Requirements	
		NRC X 270 Epoxy[a]	NRC 1174/3 Epoxy[b]	Molding Compounds (MIL-M-14E)	Fabric-Reinforced Laminates[c]
Ult Ten Str, 1000 psi	1012	25 ± 3; 31	21	6	40
Initial Mod of Elast in Tension, 10^6 psi		6 ± 0.2	5.5	—	—
Ult Flex Str, 1000 psi	1031.1	44 ± 2.5; 52	42	8	50
Flex Mod of Elast, 10^6 psi		6 ± 0.3	5.2	—	2.5-3.0
Ult Compr Str, 1000 psi	1021	52 ± 4; 61	51	15	35
Compr Mod of Elast, 10^6 psi		6 ± 0.2	4.8	—	—
Water Absorption, %	7031	0.01	0.01	0.10	0.5-1.25
Specific Gravity	5021	2.15	1.9	—	—

[a]Most recently developed Narmco resin; first value given is average value ±standard deviation, second value is maximum obtained.
[b]Values are maximum obtained.
[c]Values represent highest mechanical specifications for fabric-reinforced plastics. Specifications are MIL-R-7575-Polyester, MIL-R-9299-Phenolic, and MIL-R-9300-Epoxy. Where ranges are given, values differ between specifications.

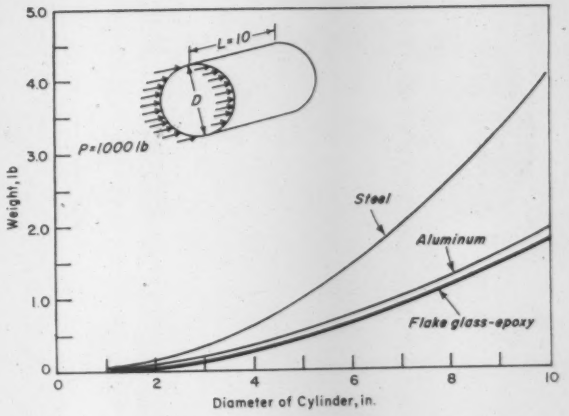
TABLE 2—ELECTRICAL PROPERTIES: FLAKE GLASS-EPOXY VS STANDARD LAMINATES (1/32-In. Thickness Except Where Noted)

Type →	Glass Flake-Epoxy	Glass Cloth-Epoxy	Glass Cloth-Melamine	Glass Cloth-Silicone	Paper-Phenolic	TFE Fluoro-carbon
NEMA Grade →	—	G-10	G-5	G-7	XXXP	—
Dielec Const (condn D 24/23)						
1 mc	4.6	5.4	8.0[b]	4.5	4.8	2.0
10^4 mc	4.05; 4.10[a]	—	—	—	—	2.0
Dissip Factor (condn D 24/23)						
1 mc	0.019	0.035	0.08[b]	0.07	0.0035	0.0003
10^4 mc	0.022; 0.024[a]	—	—	—	—	0.0003
Dielec Str (perp, step-by-step), v/mil	2500-3200[c]	500[b]	220[b]	350[b]	470[b]	500[b]

[a]First value dry; second value after 2-hr boil in water. [b]⅛-in. thickness.
[c]0.010-in. thickness; values as high as 7000 v/mil have been observed on 30-mil specimens.



2—*Comparison of weights of plates of a size that will not buckle in compression; flake-reinforced laminates vs steel and aluminum.*



3—*Comparison of thin-walled cylinders in compression; flake-reinforced laminates vs steel and aluminum.*

pletely reversed axial stress; as can be seen, epoxy laminates stressed at 0 deg to warp can be stressed to almost 40% of initial tensile stress. The epoxy in other directions, and the polyester in any direction, lose substantially greater strengths. Consequently, although initial tensile strengths of cloth laminates are greater than those of flake laminates, allowable design stresses for the two materials under fatigue loading conditions are quite similar.

Electrical properties

Table 2 compares some electrical properties of flake laminates (65% glass by weight) with those of several standard materials. Note that a phenomenal dielectric strength of 7000 v per mil has been observed on 30-mil thick flake laminates; typical values are more often in the range of 3200 v per mil.

Short-term corona discharge has no effect on dielectric strength.

Thermal properties

Preliminary evaluations of ablation characteristics of flake laminates show them to be good. Thermal conductivity at 250 F (70% glass flake by weight) is on the order of that of fiber-reinforced laminates, i.e., 1.5 Btu/hr/sq ft/°F/in.

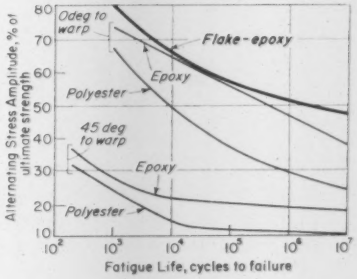
Burn-through tests on such a flake-reinforced epoxy laminate with an oxyacetylene torch indicate that the laminated structure requires twice as long to burn through as a fibrous glass-reinforced epoxy laminate. The flake-epoxy was even superior to a fiber-reinforced phenolic.

Because of the difficulty in forming high quality flake laminates with volatile-containing resins, phenolic laminates made with flake were poorer than the epoxy laminate, even though phenolic would be the more desireable binder for ablation use.

What's the potential?

The potential of a flake configuration as a reinforcing medium has been investigated extensively under Navy sponsorship. The aim was to determine what maximum theoretical strengths obtainable with such a reinforcement might be.

By idealizing the problem, and basing our calculations on a disk shape as a model element, we analyzed the effects of slenderness ratio of the flake itself, flake distribution in the laminate, and glass-resin ratio. We then developed an equation for ultimate strength of such a composite, the variables being the ultimate tensile strength of the glass and resin, and the glass-resin ratio.



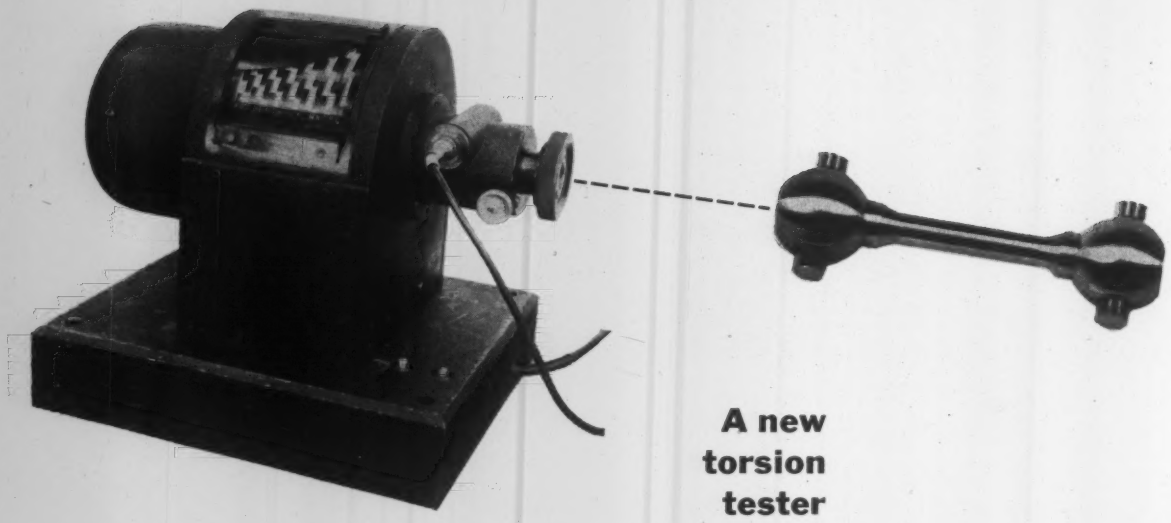
4—*SN curves for a flake-reinforced epoxy laminate compared with cloth-reinforced epoxy and polyester laminates. Curve for flake-epoxy from Narmco; other curves from MIL Handbook 17.*

The validity of the equation was verified by testing small model composites made up of machined metal disks and resin binders.

As a result of this theoretical analysis we concluded: 1) in general, if the binder has negligible tensile strength compared with that of glass, less than half the basic strength of the reinforcement can be obtained in such a composite, and 2) if stronger flake-reinforced laminates are to be developed, they will require stronger flake than now available and/or stronger binders.

Reference

"State of The Art: Flake Glass Laminates," PLASTEC Report 1. Plastics Technical Evaluation Center, Picatinny Arsenal, Oct '60.



A new torsion tester helps to

Determine Impact Properties

■ A kinetic torsion tester newly developed at Frankford Arsenal helps avoid two major problems normally encountered in determining the dynamic torsional properties of metals:

▸ Bending or distortion of low strength metals. These introduce errors in the test results.

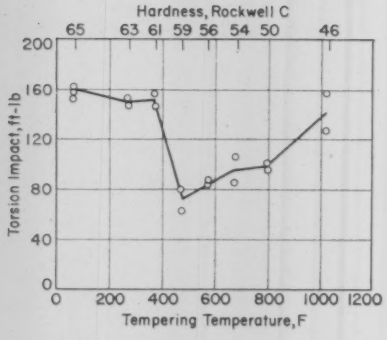
▸ Shattering of extremely hard metals. This has made it difficult or impossible in the past to obtain information on certain materials.

The new tester should make it possible to fully explore the mechanical properties of ultra high strength materials, e.g., steels for missile and rocket motor cases, and thus reduce premature forming or performance failures. No kinetic torsion tester is now commercially available.

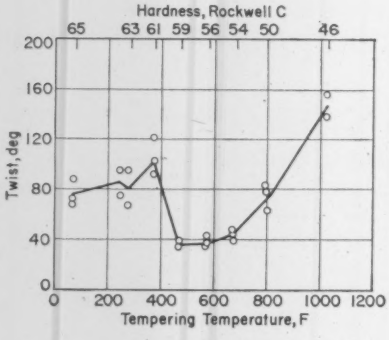
Five types of data

The value of the kinetic torsion tester lies not only in the variety of data that can be developed but also in the reliability and reproducibility of test results. As with all test data, results are valuable not for themselves but for the wide range of comparisons that they make possible.

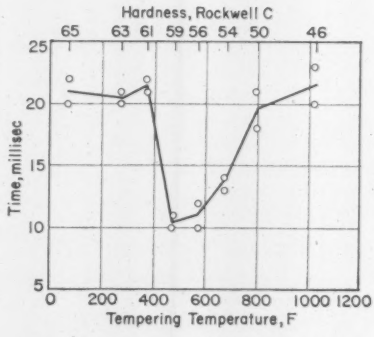
Here is how the tester determines . . .


Hardness, Rockwell C
65 63 61 59 56 54 50 46
Torsion Impact, ft-lb
200 160 120 80 40 0
0 200 400 600 800 1000 1200
Tempering Temperature, F

Fracture energy. *It is calculated from the decrease in flywheel velocity caused by impact and fracture of the specimen.*



Twist to fracture. *This is important only when compared with other data. Curve shows ductility minimum associated with blue brittle range.*



Time to fracture. *Another measure of ductility, it can be developed by examining the oscilloscope trace of each test.*

by J. D. Corrie
and
J. M. McCaughey,
Pitman-Dunn Laboratories, Frankford Arsenal

# of High Hardness Materials

This tester can compare materials on the basis of composition, treatment or processing factors to screen out those that will not meet required stress levels. In addition, it can measure performance in terms of milliseconds, a feature not normally available in commercial testing machines.

Four measures of ductility: Graphs on the preceding page show how the kinetic torsion tester is used to determine these three indicators of ductility:

- Fracture energy
- Twist to fracture
- Time to fracture

All of these data were developed for a 0.75% carbon, low alloy steel which ranged in hardness from 65 to 45 Rockwell C. Although data are available for the lower end of the hardness range, no information had been available previously for the higher hardness specimens.

A fourth parameter, maximum torque, can also be determined from data obtained with the tester.

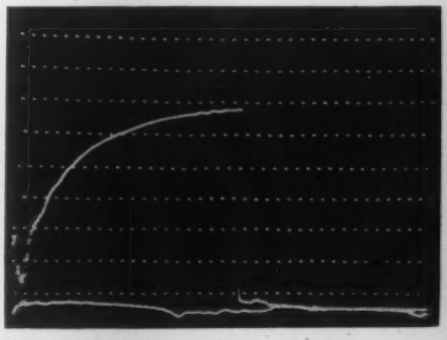
Instantaneous shear stress: Another type of information obtained from the tester, instantaneous shear stress, is particularly important in applications where a material is being dynamically loaded in shear or torsion. In those applications where shear stress is required to peak, such as a rocket or missile quick-disconnect shear bar, comparing instantaneous shear stress is another way to quickly check performance of a group of materials.

The photograph below is an oscilloscope trace of a test on a single specimen. The spacing between dots on the horizontal scale represents 1 millisec and the vertical space between the lines is the voltage change resulting from the increasing magnitude of applied torque. A calibration factor converts voltage change into torque so that shear stress in the outer fibers can be calculated at any instant during deformation.

Recessed flywheel

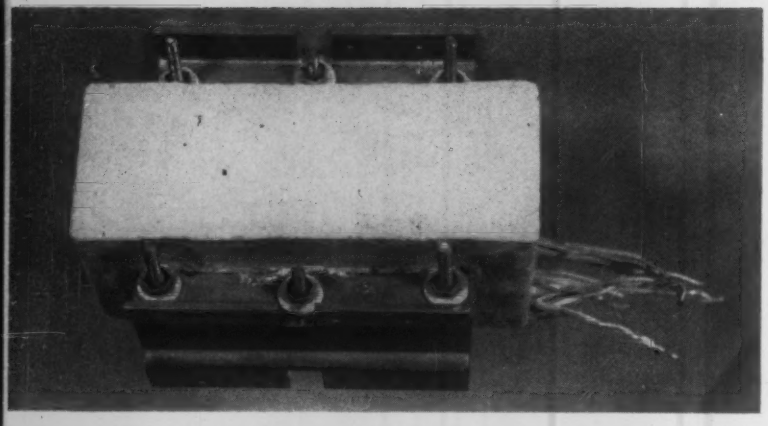
The kinetic torsion tester, in essence, is a motor with a heavy flywheel attached; the flywheel is recessed to accommodate one end of the test specimen. One end of the specimen rotates within the flywheel and the other rests in a rotatable collar which, when engaged, allows the flywheel to apply the torque needed to twist the specimen to fracture. The tester and a typical test specimen are shown on the preceding page.

The shape of the specimen is an important feature. The spherical portions, which are outside the gage length, permit the ends of the specimen to seat themselves properly in the machine. A slight amount of eccentricity or misalignment, therefore, will not produce a bending moment and the pure shear quality of the test is always maintained.



Oscilloscope trace *shows torque vs time record for an 0.75% carbon, low alloy steel hardened to 62* R_c.

Electrical Insulations for



Power transformers *before and after potting in inorganic cement. Transformers are wound with nickel-plated copper wire coated with pigmented polyester enamel.*

by Robert J. Fabian, *Associate Editor, Materials in Design Engineering*

■ Lack of heat resistant insulation materials is a stumbling block in the development of high temperature electrical and electronic equipment. Because all conventional organic insulations are subject to rapid deterioration at high temperatures, it has been necessary to develop a whole new series of inorganic materials for transformer cores, coil spools, cable, magnet wire, and potted and encapsulated electronic components.

The complexity and scope of this new technology make it impossible to cover all new developments. However, we can learn a great deal by narrowing the field down to its most critical areas. Thus, in this article we shall see what problems are being encountered above 930 F (500 C) and what materials are proving most suitable in the two most critical types of insulation: potting and embedding components and sheathing magnet wire.

Potting and embedding materials

Aside from their higher heat resistance, inorganic potting and encapsulation materials do not provide nearly as good electrical, mechanical and processing characteristics as organic materials. But organics, for the most part, will not withstand high temperatures. Common organic materials such as polyesters can only be used to about 400 to 450 F when filled, and filled epoxies can only be used to about 500 F. Conventional silicones will withstand 625 to 650 F, though it may be possible to use modified silicones at higher temperatures.

Ideally a high temperature potting and encapsulation material should:

1. Have high mechanical strength. This is very important, especially in military equipment where high resistance to vibration is needed.
2. Have good electrical insulation properties.
3. Not shrink during or after curing.
4. Be fluid enough to be applied and handled easily.
5. Have a reasonable pot life.
6. Absorb little or no water.

As we shall see it is extremely difficult to combine all of these characteristics in the same material. By their very nature, inorganic materials have poorer strength and flexibility and less resistance to water than organic materials and are also considerably more difficult to handle. Despite these drawbacks, engineers are learning to live with the inorganics simply because they are the only materials that can be used. Following is an analysis of six major types of materials which you should investigate for high temperature applications.

930 F Plus

Air drying cements

Several air drying cements now available can be used for potting and embedding components at temperatures well over 930 F. Many of the materials were originally developed as high temperature thermal insulations for furnaces and thermocouples, and it has only lately been discovered that they can be used to both electrically insulate and protect electronic equipment at high temperatures.

Five limitations—In general, an air drying or air curing potting compound is a mixture of inorganic materials, fillers and a solvent (usually water). It is cured by evaporating the solvent at room or moderate temperatures. Producers and users alike are frank to recognize, however, that aside from high temperature properties none of these materials performs or handles as well as a conventional organic material. For example:

- Although electrical properties at high temperatures may be adequate they leave something to be desired.
- Air drying cements are quite porous and tend to absorb moisture. This would not be a problem if they operated continuously at high temperature. However, when not in use they tend to pick up moisture which can cause trouble when operation is started or resumed. In many cases you can minimize the problem by coating the material with a suitable glaze or cement, or impregnating it with an inorganic material.
- The inherent brittleness and rigidity of the materials makes them susceptible to mechanical damage. Also, because of their low coefficient of expansion compared to other materials, they tend to set up stresses and do not possess good bond strength.
- Because of their cement-like consistency the materials are usually hard to handle and are not especially good in filling voids.
- Their handling cost is relatively high; however, this factor is not usually too important for military applications.

Available materials—Most air drying cements for electronic applications are still in the experimental stage and literally dozens of different formulations are currently being evaluated. Typical of the materials now available that have proved out on a limited scale are:

- A ceramic embedding compound (Eccoceram SM-25) consisting of a silicic acid gel–bonded synthetic mica. This inorganic material is usable from —70 to 2000 F and has good mechanical and electrical properties (see Table 1).

The material comes as two components: a powder and a liquid. These are mixed to produce a flowable material which is poured into the cavity and cured at 325 F. In order to minimize mechanical damage and moisture absorption you should retain the metal or ceramic housing after curing. In most aplications the material does not need a protective coating; however, for improved moisture protection it can be suitably impregnated. (The impregnant recommended by the manufacturer provides moisture protection only to 700 F; above this temperature the impregnant decomposes into a negligible residue).

TABLE 1—PROPERTIES OF SILICIC ACID SYNTHETIC MICA CEMENT[a]

Specific Gravity	1.7
Flex Str, psi	1000
Dielectric Const (10^2-10^{10} cps)	Approx 3.6
Dielec Str, v/mil[b]	100
Dissip Factor (10^2-10^{10} cps)	<0.004
Volume Resistivity, ohm-cm	
70 F	10^{10}
1000 F	10^7
After 120 hr at 90% RH, 70 F	
Not Impregnated	10^6
Impregnated	10^{12}

[a]Eccoceram SM-25. [b]100-mil sample.

HIGH TEMPERATURE POTTING AND EMBEDDING MATERIALS

Air Drying Cements	Withstand high temperatures but have relatively poor electrical and mechanical properties, absorb moisture, are hard to handle, and are relatively costly
Chemical Setting Cements	Combine low shrinkage, high insulation values, low porosity, adequate mechanical strength
Sintered or Fused Materials	Have high strength at high temperatures but require high curing temperatures
Alumina Powder	Handle easily, have good dimensional stability, and require no curing
Silicone Resins	Must be used in inert gas atmosphere, but have good electrical and mechanical properties
Hydraulic Setting Compounds	Have variable electrical properties, high shrinkage, low bond strength

TABLE 2—TYPICAL PROPERTIES OF CERAMIC POTTING COMPOUND[a]

MECHANICAL PROPERTIES	
Cross-Binding Strength, psi	
After Curing at 572 F	2565
After Curing at 1112 F	3360
Shear Strength[b], psi	390
Moh Hardness	2-3
ELECTRICAL PROPERTIES	
Resistivity, ohm-cm	
1472 F	5×10^7
1562 F	9.2×10^6
1652 F	3.9×10^6
1742 F	1.6×10^6
Dielectric Strength, v/mil[c]	85.3

[a]Allen PBX.
[b]Max value obtained on sand-blasted Stellite 25.
[c]Avg. value obtained with specimens of 0.055-in. average thickness. Specimens cured at 572 F.

TABLE 3—PROPERTIES OF SILICONE-SILICATE-ASBESTOS COMPOUND[a]

Specific Gravity	1.5
Dielectric Str, v/mil	500
Radiant Heat Resistance	
2000 F	Continuous
6000 F	15 sec (carbonizes)
Ther Cond, Btu/hr/sq ft/°F/in.	
600 F	1.8
900 F	2.2
Ther Exp Coef (77-1292 F), per °F	6.2×10^{-6}

[a]All values listed are for PT-209 (Product Techniques, Inc.), a sprayable thermal insulating compound. Properties of potting compound PT-209-P are substantially the same, the only notable difference being in solids content.

TABLE 4—PROPERTIES OF A TYPICAL SILICO-CERAMIC POTTING COMPOUND[a]

MECHANICAL PROPERTIES	
Compr Str, psi	1000
Transverse Str, psi	300
Mod of Rupture, psi	300
Moh Hardness	1
Shrinkage During Cure, %	1.5
ELECTRICAL PROPERTIES	
Resistivity, ohm-cm	
77 F	10^{14}
752 F	10^{11}
Dielec Str (60 cps), v/mil	150
Loss Factor (100 mc)	0.009
Dielec Const	2.8
THERMAL PROPERTIES	
Continuous Temp Limit, F	2000
Short-Term Temp Limit, F	2400
Ther Exp Coef (392-1652 F), per °F	2.5×10^{-6}

[a]Physical Sciences Corp. Water Mix 0306 for general encapsulation. Other formulations available (with or without hardeners).

▶ A ceramic compound (Allen PBX) originally developed for strain gage and thermocouple applications, which designers have recently found to be suitable as a high temperature potting material (for example, see "Ceramics, Graphite Beat Heat in 870 F Motor," M/DE, May '61, p 132). This compound is applied much like the above material (however, its section thickness is limited) and can be cured by air drying or oven heating. Table 2 shows typical mechanical and electrical properties after curing.

▶ An inorganic potting compound (Product Techniques-209-P) containing a proprietary mixture of silicones, silicates, asbestos and other inorganic fillers. Like many other inorganic potting compounds this material was originally developed as a high temperature thermal barrier. However, by making minor modifications, producers have found that it can also be used as a potting compound in section thicknesses to about ½ in. Typical properties are shown in Table 3.

Chemical setting cements

Although chemical setting cements offer significant advantages only at high temperatures, in some lower temperature applications where requirements are not too severe they can actually be cheaper to use than organic materials. A wide variety of compounds are available most of which are characterized by:

1. Low shrinkage properties.
2. High electrical insulation values when suitably formulated.
3. Relatively low porosity—about half that of other cements.
4. Adequate pot life.
5. Suitable mechanical strength for many military applications.

As their name implies, chemical setting cements cure and harden through chemical interaction of the component materials. Cements fall roughly into four types: phosphate-bonded, ethyl silicate-bonded, oxychloride-bonded and sulfate-bonded. Of these, the phosphate-bonded type probably has the best all-around combination of properties. Some notable differences between the different types:

▶ The silicate type has relatively low insulation resistance at high temperatures.

▶ Oxychloride and sulfate types are generally weaker than the others.

▶ Silicate and phosphate types may have a slight edge in processing characteristics.

In conducting a special high temperature (930 F) evaluation for the Air Force, General Electric Co. has found that an inorganic aluminum phosphate solution can be successfully used as an impregnant for transformer coils. This material imparts rigidity and toughness to the coil without significantly altering the basic properties of the insulation system. Disadvantages of the material include low solids content, slight corrosiveness, and an affinity for moisture.

In a separate study Westinghouse Electric Corp. has found that a satisfactory potting compound for 930 F operation can be formulated using a phosephate solution, Wollansite C-1, Kyanite and silica. Water additions up to 5% can be made to adjust viscosity. The composition has a 1 to 2-hr pot life at room temperature. The system is easy to apply, has good electrical properties and provides good protection for such items as motor end windings. Some hairline cracking occurs in thick sections and on certain difficult contours. Resistance to mechanical shock, vibration and moisture is only fair, but work is underway to improve these properties.

A series of proprietary chemical setting potting compounds is also available for protecting transformers, chokes, transducers and other coil assemblies against high temperatures. Three standard silico-ceramic formulations (Physical Sciences 0306, 0307, 0308) are claimed to be usable at temperatures up to 2000, 3000 and 4000 F, respectively. Since the materials (see Table 4 for properties) are sensitive to moisture you should use them within a shell or housing which can be sealed if extra moisture protection is needed.

Sintered or fused materials

Components can also be protected against high temperatures by coating or potting them with an inorganic material which is sintered or fusion bonded in place. Varying degrees of success have been obtained using such inorganics as ceramics, glazes and glass. These materials have high strength at high temperatures. However, the very high sintering temperatures required may damage components. Also, some compounds tend to have poor green (uncured) strength and undergo high shrinkage during firing. However, the bond obtained with fusion bonded inorganics is better than that obtained with other high temperature materials and is most nearly similar to that of plastics.

Typical of the fusion bonded systems that have been developed to date is Westinghouse Electric's three-step process (Fig 1). This process consists of:

1. Coating and/or potting the components with a porous material containing reactive components (two typical water suspension compositions are shown in Table 5). You can apply these materials to components during winding as an interlayer coating and/or impregnate them into the windings from a slurry, sol or solution. The method of application depends on the winding procedure, the physical configuration of the component, and electrical requirements.

2. Vacuum impregnating the assembly with certain glass compositions at a high temperature. The impregnant must be fluid at a temperature below the temperature limit of the components. The best impregnants evaluated to date are a lead oxide-boric oxide eutectic (88 PbO–12 Bi_2O_3) which reaches sufficient fluidity for vacuum impregnation at about 1160 F; and a lead oxide–bismuth trioxide eutectic (72 PbO–28 Bi_2O_3) which reaches sufficient fluidity at about 1250 F. A material such as Corning Soldering Glass #7570 can be used at 1380 F; however, it is more viscous than desired. Similarly, lead borosilicate glasses do not reach low enough viscosity for vacuum impregnation even at 1380 F.

3. Heat treating the assembly until the impregnant reacts with the potting compound and internal inorganic insulation. During heating the composition of the impregnant changes so as to improve the physical and electrical properties of the insulation system (see Table 6). You can obtain a wide range of electrical and thermal properties by tailoring the composition of the potting compound and impregnant. Thus, although present formulations are designed for use up to 930 F, suitable adjustments permit use up to 1000 F (540 C).

TABLE 5—TYPICAL POTTING COMPOUND COMPOSITION FOR FUSED INSULATION SYSTEM
(Parts by Weight)

Ingredient ↓	Formula A	Formula B
Zircon		
60 Mesh	—	25
200 Mesh	110	100
Fused Aluminum Oxide (Al_2O_3)		
220 Mesh	10	100
1000 Mesh	—	100
Vitro Frit VG-260, 200 Mesh	—	35
Corning Glass 7570, 200 Mesh.	5	—
Water	25	80
Methocel, 1% Soln	—	0.5
Marasperse CB	0.3	0.5

TABLE 6—INSULATION RESISTANCE OF FUSED INSULATION SYSTEMS (Megohms)

Temp, F ↓	Formula A[a]		Formula B[a]	
	Before Aging	After Aging 16 Hr at 959 F	Before Aging	After Aging, 16 Hr at 1139 F
Room	13,500	>100,000	>100,000	>100,000
392	1,700	6,000	6,500	>100,000
572	13.5	51.5	50	8,000
752	0.205	1.22	1.2	70
932	<0.08	<0.08	<0.08	3.3

[a]Formulas A and B (see Table 5 for composition) impregnated with lead oxide-boric acid eutectic.

Westinghouse Electric Corp.

1 Coils *are encapsulated by vacuum impregnating insulation system with molten glass.*

Alumina powder

Alumina (Al_2O_3) powder has proved quite satisfactory as a potting or filling compound in hermetically sealed metal enclosures. To date, the powder has been used in relatively low temperature applications such as classes 105 C, 155 C and 180 C. However, since alumina is a refractory material it should be capable of withstanding temperatures over 1800 F.

As shown in Table 7, the material compares quite favorably with organic and other inorganic potting compounds. Other advantages of the material:

- It undergoes little expansion or contraction despite wide temperature variations. This means that it will not impart stresses to sensitive components.
- No curing is required. Thus, ventilation and equipment such as hot plates and ovens are not necessary.
- There is no fire hazard.
- Repairs or changes can be made readily because the material retains its granular characteristics, always pouring and handling easily.

TABLE 7—HOW ALUMINA COMPARES WITH OTHER POTTING COMPOUNDS[a]

Type →	Silicone-Treated Alumina Powder	Sand-Asphalt Compound	Epoxy Resin	Wax	Ceramic Encapsulant
Specific Gravity	1.2	1.65	1.64	0.9	2.4
Insulation Resistance, megohms	10^5	7×10^5	$>10^6$	$>10^6$	$>10^6$
Heat Reduction, %	41	43	54	38	45
Cost,					
$/Lb	0.58	0.4	0.42	0.23	1.35
¢/Cu In.	2.5	2.4	2.5	0.8	11.7

[a]From *Kirkwood and Key.*

▶ It provides good properties at low as well as high temperatures.

The consistency of aluminum oxide is such that it can be poured easily into a potting enclosure. You can pack it quite easily by using a vibratory table or even by merely tapping the side of the can. Although the material is available in various shapes, spheres have proved best for potting because unlike irregular shapes they do not act as an abrasive when vibrated.

In order to eliminate the problem of water absorption and attendant drop in insulation resistance, users recommend that the alumina powder first be treated in a solution consisting of 2 parts silicone resin (50% solids by weight) and 100 parts of a solvent such as xylene. This treatment markedly improves the insulation resistance of the powder without affecting handling characteristics or other electrical properties.

Silicone resins

As a result of recent developments, Raytheon Co. reports that certain types of silicone resins which are unstable when exposed to air at temperatures above 480 F can be used in inert gas atmospheres up to 1100 F.

To accomplish this you must de-gas the resins under vacuum at a high temperature following the usual 390 F cure. Weight loss when heated in vacuum at temperatures up to 1100 F is about 25%, as compared to 50% for the same resin when heated in air. This indicates that a large portion of carbon still remains in the molecule after vacuum treatment.

Properly selected and treated resins retain a large measure of their bonding strength, exhibit excellent electrical properties, and can operate for long periods at very high temperatures without further degradation. Furthermore, by adding refractory powders and inorganic fibers to the basic resin it is possible to produce potting compounds having zero shrinkage, controlled porosity, and resistance to shock and vibration.

Hydraulic setting compounds

Hydraulic or water setting compounds such as plaster of paris and calcium aluminate have received considerable attention as potting compounds, but results show that the materials are generally unsatisfactory. Curing is accompanied by a change in state and the formation of crystals. The resulting structure, like that of air drying cements, is porous and thus susceptible to moisture damage.

On the basis of their electrical properties alone it is questionable if the materials are suitable for electrical equipment. Some materials and batches display good electrical properties; however, properties can vary from material to material and batch to batch. A further disadvantage is the bad effect that high temperatures have on the materials, particularly the destruction of crystalline structure. Shrinkage after firing is high enough to cause trouble. Also, bond strength is much lower at high temperatures than at room temperature.

Magnet wire insulation

Unlike potting and embedding compounds, magnet wire insulations are not selected alone, but as a materials system consisting of the insulation itself plus the base wire. This is particularly important since high temperatures often produce a reaction between the insulation and the wire.

Inorganic-insulated wire unfortunately exhibits few, if any, of the desirable properties we have come to associate with conventional enamel-coated magnet wire. Engineers are learning to live with a new class of materials which, aside from different composition, have distinctly poor mechanical properties, barely adequate electrical properties, and difficult handling characteristics. Despite these shortcomings, inorganic-coated wire is often the only materials system that will stand up to increasingly high temperatures.

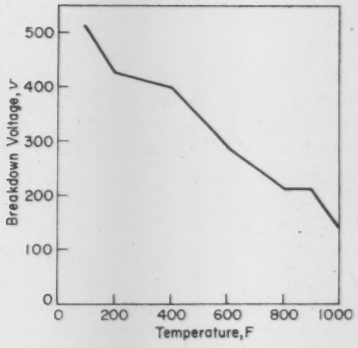
Here are some of the materials systems you should consider for high temperature use.

Ceramic coated wire

Ceramic coatings have probably been investigated more thoroughly than any other class of high temperature magnet wire insulation. Literally hundreds of experimental coatings have been formulated and much work is still underway. At present the state of the art is complex and confusing, even to trained observers. However, it is possible to arrive at some useful conclusions on those ceramic insulations which are now available in semicommercial or commercial quantities (Table 8). For example:

Nickel-clad copper with a ceramic coating is reported to be a very acceptable material for power transformers and inductors operating at 930 F. Users report that diffusion of the nickel and copper can cause a permanent change in resistance. However, this change may not be severe for

HIGH TEMPERATURE MAGNET WIRE INSULATIONS	
Ceramic-Coated, Nickel-Clad Copper	Has acceptable electrical properties at high temperatures. Metallic diffusion may affect resistivity; elongation may cause failures
Ceramic-Coated Copper	Offers good flexibility and mechanical properties
Ceramic-Silicone Coatings	Are not potentially useful above 750-840 F
Ceramic-Coated, Inconel-Clad Copper	Does not retain good initial electrical properties at high temperatures
Anodized Aluminum	Has good electrical properties, but melting point is low and it is hard to connect and solder. Hard to obtain thin, uniform anodized coatings
Glass-Served Magnet Wire	Has good workability, flexibility during processing
Inorganic Pigmented Enamels	Has good flexibility
Fluoride Coatings	Offer good flexibility and low porosity



2 Breakdown voltage *vs temperature for double layer of glass insulation over copper conductor.*

short-time operation at temperatures as high as 1100 F (600 C). Users also caution that coating elongation can cause problems, e.g., winding under normal tension can produce a break in the coating and expose the conductor.

Copper with a ceramic coating was one of the first insulation systems developed for high temperature use. Continued development has resulted in materials with good flexibility and bond strength. However, most of the early formulations are generally unsuitable for use over 930 F.

Much work is currently underway to raise the temperature limit of these insulation systems, and preliminary results with some materials, such as two coats of a glass material (known as 58 C), look favorable (Fig 2). Electrical properties of the material depend heavily on how it is formed. Thus, such factors as the ratio of mandrel diameter are extremely important. The materials system shown in Fig 2 has a ratio of 109, but when the wire is formed with a ratio of about 12 the coating fractures, thus reducing breakdown voltage to zero at 800 F.

Stainless-clad copper or nickel-clad copper with a ceramic-silicone coating (Table 8) is potentially useful where operating temperatures do not exceed 750 to 840 F (400 to 450 C). Stainless steel-clad copper shows unusual d.c. resistance stability even after exposure for 1000 hr at 1100 F (600 C). Unfortunately, however, other properties deteriorate at this temperature.

Inconel-clad copper coated with ceramic, although suitable for moderate temperatures, does not retain good electrical properties at high temperatures. For example, one user reports that at 1100 F the material has no measurable strength, despite the fact that after 1000 hr the material shows no visual damage.

Silver wire with a ceramic-acrylic coating also appears to be unsuitable for use at high temperatures. Independent laboratory tests on 0.0126-in. dia wire show that the material loses its electric strength after only 40 hr exposure at 570 F (300 C).

TABLE 8—TYPICAL PROPERTIES OF CERAMIC COATED MAGNET WIRE[a]

Coating Type	Wire Material	Insulation Resistance at 1000 F, megohms	Dielectric Strength	Dielectric Constant	Continuous Temp Rating, F[b]
Ceramic (Ceramacite)[c]	Nickel-clad copper	130	150 v d.c.	—	1000
Ceramic (Ceramacite)[d]	Nickel-clad copper	2	400 v/mil at 86 F	11 at 86 F, 22 at 1000 F	1000
Ceramic (Ceramatemp)[e]	Nickel-clad copper	3	300 to 700 v/mil	11 at 86 F, 22 at 1000 F	1000
Ceramic (Type B)[f]	Any	0.07	150 v at 1000 F	—	1200
Ceramic (Type C)[f]	Any	0.2	250 v at 1000 F	—	1200
Ceramic[g]	Inconel-clad copper	—	30 v at 932 F	—	—

[a] From WADC Technical Report 59-348. Except for last material all information is supplied by manufacturer. Dielectric strength values are for unflexed specimens; values may be much lower after winding into electrical equipment.
[b] Manufacturer's ratings.
[c] Consolidated Electrodynamics Corp.
[d] Sequoia Wire.
[e] Hi Temp Wires, Inc.
[f] Secon Metals Corp. Coated conductor is supplied in semicured state. System is cured after winding: Type B at 1100 F, Type C at 1425 F.
[g] General Electric Co.

Anodized aluminum wire

Anodized aluminum magnet wire is available in two forms: anodized alumina-clad copper wire and anodized plain aluminum wire.

Anodized aluminum-clad copper wire was one of the earliest high temperature wire systems to be developed. After intensive investigations by many laboratories its suitability for high temperature applications is still inconclusive.

A major difficulty encountered with this material is inability to obtain thin, uniformly coated, aluminum-clad wire for anodizing. Coatings obtained with both phosphoric acid and sulfuric acid-magnesium chloride electrolytes have been satisfactory except for their inability to completely convert all of the surface of aluminum wire to alumina. Sulfuric anodized coatings 0.3 to 1 mil thick can be obtained on 0.02-in. dia wire. However, poorly anodized areas less than 0.3 mil thick can result in diffusion of aluminum into the base copper conductor above 1000 F, thus causing the wire to become very brittle. One commercial product is said to be usable to 1900 F when barrier layers of nickel and silver are introduced between the aluminum and copper. However, one user reports that these barrier layers have not prevented diffusion of unanodized aluminum into the copper above 1000 F. He asserts that aluminum-coated wire should have a uniform coating of aluminum 0.3 to 0.5 mil thick and should be provided with a thin barrier layer of chromium, iron or other metal.

High temperature properties of anodized aluminum-clad copper can be improved by coating it with a suitable sealer. Colloidal silica sealers have not proved successful; however, good results have been obtained by introducing a true solution of ethyl silicate into the pores of the anodized layer. Gelling the ethyl silicate forms particles of silica which remain in the pores.

By far the best sealing and electrical properties are obtained with frit-resin coatings, notably those composed of one part frit (3419) to two parts silicone resin (Dow Corning 806A). These coatings provide low dielectric constant, low dissipation factor and good continuity, and have proved serviceable after 750 hr at 800 F.

TABLE 9—ELECTRICAL PROPERTIES OF GLASS-SERVED MAGNET WIRE[a]

Temperature, F (C)	Insulation Res, megohms	Electric Strength, v
77 (25).....	1000	1100
572 (300).....	320	740
932 (500).....	210	700

[a]An experimental system developed by Westinghouse Electric Corp.

TABLE 10—PROPERTIES OF INORGANIC-PIGMENTED MAGNET WIRE INSULATION[a]

Conductor →	Silver	Nickel-Plated Copper
Electric Str, v.....	660-1000	320-560
Insul Res, megohms[b]...	250	2500
Cut-Through Temp, F...	1252	1310
Adhesion.....	Good	Fair

[a]After burn-out.
[b]Determined on dielectric twisted pairs at 100 v.

Anodized plain aluminum wire has been under development for many years. Some laboratories report good results with the material; other reports are unfavorable. Some of the difficulties encountered with the material include:

- Low conductivity relative to copper. Since the conductivity of anodized aluminum is only about 60% of copper's this can be a mitigating selection factor. It is not an important factor with aluminum-clad copper because the aluminum coating is relatively thin.
- Low melting point. Despite the protection afforded by an anodized aluminum oxide layer, the mechanical properties of the base aluminum begin to drop off around 1000 F (aluminum's melting point is 1215 F).
- Difficulty in connecting and soldering leads. Because the insulating oxide layer is tenacious it is difficult to remove the coating at conductor ends for connections. Also, coated conductors are not very flexible, and in certain applications (e.g., motors) cracks may develop where the wire has been bent.

With all these drawbacks, however, anodized aluminum conductor has good electrical properties at medium temperatures. Electric strength, for example, remains stable from room temperature to 660 F (350 C). One user reports that the material performs surprisingly well with miniature power transformers up to 1100 F, and he would probably recommend the material if it could be drawn to fine wire sizes (which it cannot) and if the connection problem could be solved. Again on the plus side, the material has a low space factor and its weight is about one-half that of copper for the same electrical capacity.

Glass-served magnet wire

Another approach in designing magnet wire insulation is to use a serving of glass fiber impregnated with inorganic binders and fillers. An experimental system of this kind has been used successfully on motors operating at 930 F for over 500 hr.

Essentially, the system consists of aluminum wire (silver and nickel-plated copper can also be used) covered with two layers of glass fiber. The composite is passed through a suspension of powdered mica and a phosphate solution and fired at 480 F. Processing requirements are simple and only low cost materials are needed. When suitably formulated the insulation's resistance (Table 9) is equivalent to that of glass-served, organic-coated wire.

The insulation maintains its flexibility without flaking and can be easily wound and unwound from its spool. It is also noted for its workability during processing into electrical equipment. It does not have as high a scrape resistance as organic enamels; however, this property can be improved considerably by adding alumina.

Another glass-served system that has proved itself in 930 F service consists of two layers of glass impregnated with silicone resin. The silicone provides strength for winding and is subsequently volatilized by heating 4 hr at 930 F. This tends to make the glass somewhat fragile; however, if it is properly supported in a coil it can remain undisturbed during mechanical stress. The glass serving adds about 8 mils to the coil diameter and is compatible with most base conductor materials. Some interaction may occur between glass and silver during aging in air at 1100 F but this is not a problem in hermetic, air-free transformers.

Inorganic pigmented enamel

It is possible to improve the flexibility of inorganic insulation materials by combining them with flexible organics. This has been done with a magnet wire insulation developed by Westinghouse Electric Corp. containing: 1) special polyester resins to provide flexibility to facilitate winding, 2) inorganic refractories such as silica which serve as a wire separator during the glass fusing process and partially dissolve into the glass to raise its fusion temperature; and 3) glass frits which fuse during heating and provide the necessary electrical properties and heat resistance.

The composition is applied directly to the wire which is subsequently wound into electrical equipment. After winding, the organic portion is burned out and the glass frit is fused to bind the refractory.

The principal reason for using polyesters is that they burn clean and do not have a carbon residue. Also, you can formulate them for maximum inorganic pigment loading, e.g., 50% pigment, 50% polyester resin solids.

Since the glass frit is fused after winding, it must have a fusion temperature that is not injurious to the rest of the equipment. The glass must also retain sufficient insulation resistance and resistance to cut-through at high temperature. Various glasses have been tried, one of the most successful being a barium-modified glass frit with a 1070 F (575 C) sag point. This glass has been incorporated into a formulation containing 50% polyester resin, 30% silica and 20% glass frit for use on silver and nickel-plated copper conductors. Table 10 gives typical properties.

Special polyester enamels can also be used in conjunction with glass served magnet wire to improve abrasion resistance of the glass during winding and fabrication. After assembly the polyester is burned out, leaving a harmless residue behind.

Fluoride coatings

Bell Telephone Laboratories has developed fluoride coatings for aluminum and copper conductors which it claims will allow the conductors to be used up to their melting point. The coatings are formed by exposing the metal to an oxidizing carrier of fluorine, such as hydrogen fluoride, at high temperatures.

The coatings, integrally bonded and strongly adherent to the base metal, are noted for their flexibility; however, their moisture resistance is poor. Typical coatings on aluminum have an insulation resistance of about 7×10^8 ohms at 930 F. Dielectric strength at this temperature is greater than 450 v.

CLASSIFICATION OF ELECTRICAL INSULATION MATERIALS

Temp Class[a] ↓	Temp, F	Letter Class
90 C	194	O
105 C	221	A
130 C	266	B
155 C	311	F
180 C	356	H
220 C	428	None
Over 220 C	>428	C

[a]Temperature at which materials are capable of operating. Temperature classification system (in °C) is now preferred by AIEE; however letter classification system is still in common usage.

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Westinghouse Electric Corp.
Aeronautical Systems Div., USAF

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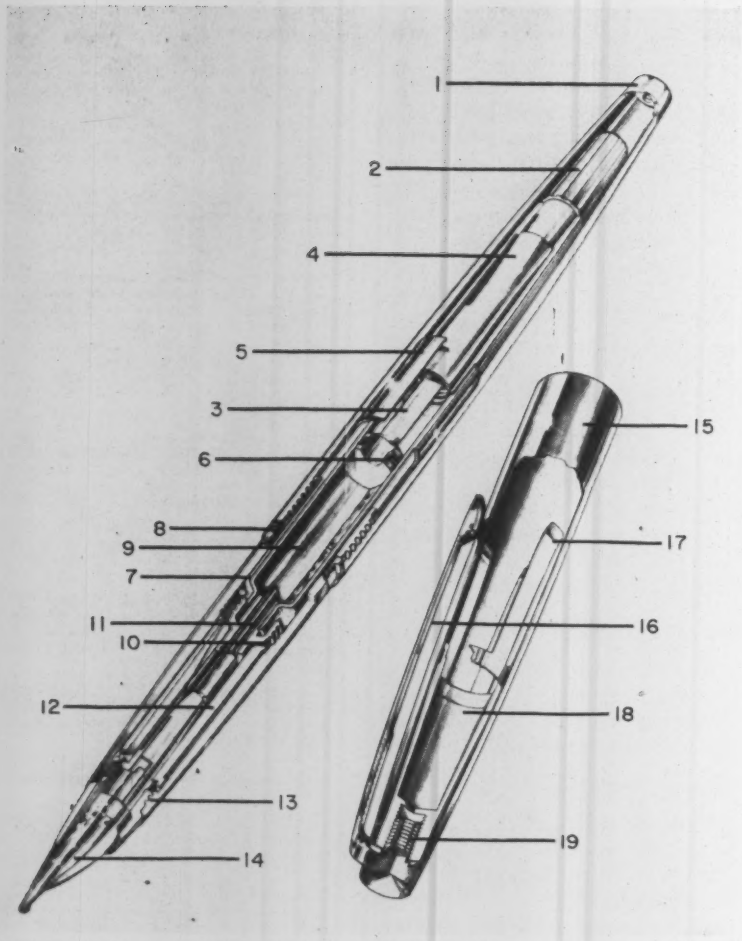
Redesign, new materials give . . .

A Quality Pen

by H. T. Green, *Product Engineer,*
and **P. C. Johnson,** *Plastics Engineer, The Parker Pen Co.*



***New fountain pen** with refillable unit installed. Numbered parts are identified in the table on opposite page.*

■ The skillful combination of new design, careful selection of new materials, and development of new processing methods has enabled Parker Pen Co. to manufacture a fountain pen with quality features previously found only in a much higher priced product.

Aesthetic considerations and structural requirements restricted the materials in the *external* components to those previously used; this left *internal* components as the primary source of cost reduction.

This new pen is intended to sell for $5. Unlike most fountain pens selling at this price the Parker 45 has a 14-karat gold nib. Gold is used because of its durability and consumer appeal, even though the nib represents 40% of the total permissible cost of the pen. Consequently, attention was focused on the feed, overflow collector components, and ink reservoirs as areas for cost reduction.

All previous fountain pens had used machined feed and collector components to meet close tolerances and intricate geometry requirements. By redesigning these parts, a new collector and feed were devised having a simple and therefore moldable shape. This new design, when coupled with the improved properties of high impact acrylic plastic, permitted forming by injection molding.

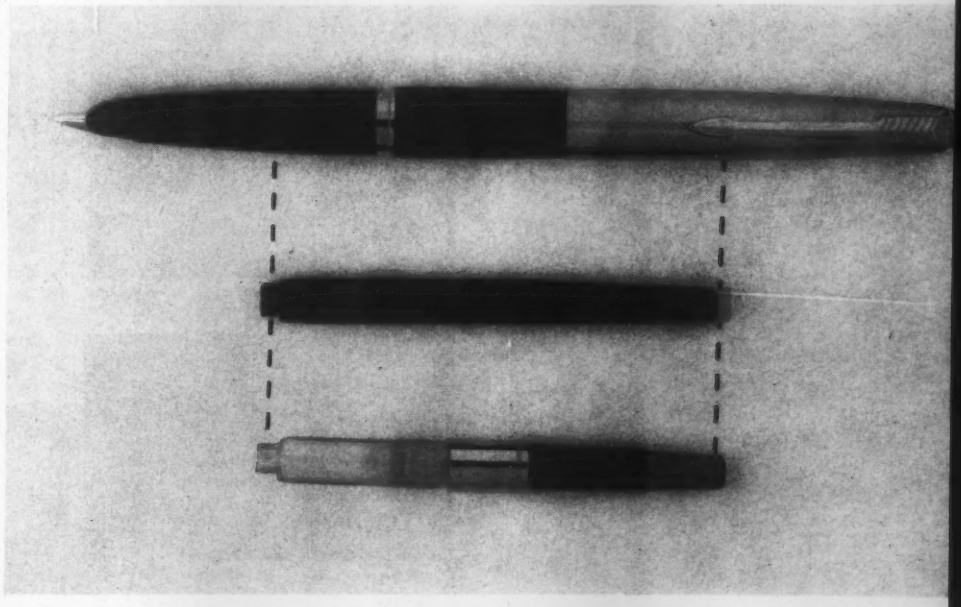
Substitution of injection molding for machining reduced the cost of the feed by 50% and the collector by 80% without impairing pen performance.

The various materials used for each component of the Parker 45 pen and their desirable properties are given in the table on the next page. Part numbers are keyed to the cutaway view of the pen at left.

at a Lower Price

MATERIALS USED IN THE PARKER 45 PEN

Part	Materials Used	Required Materials Properties
1. Barrel	High impact acrylic	High impact and hoop strength, excellent surface gloss and surface retention, formability
2. Drive button	ABS copolymer	High torque and impact strength, chemical compatibility with piston
3. Piston	ABS copolymer	Formability to ±0.001 in., chemical resistance, dimensional stability
4. Assembly sleeve	Polypropylene	High impact and hoop strength
5. Trim ring	Cartridge brass	Easy to deep draw and plate
6. O-ring	Silicone elastomer	High shear strength, chemical resistance, low compressive set, low coefficient of friction against reservoir shell
7. Collector shell	High impact acrylic	High impact and hoop strength, excellent surface gloss and surface retention, chemical resistance, easily formable
8. Barrel band	Free machining brass	Easy to machine and plate
9. Reservoir shell	Polypropylene	Dimensional stability, chemical resistance, high impact strength
10. Nipple	ABS copolymer	Dimensional stability, chemical resistance, durability
11. Feed	High impact acrylic	Formability to ±0.001 in., chemical resistance
12. Collector	High impact acrylic	Formability to ±0.001 in., dimensional stability
13. Nib collar	ABS copolymer	High impact and hoop strength, chemical resistance
14. Nib	14-k gold	Chemical resistance, decorativeness
15. Cap	Type 304 stainless steel	Chemical resistance, decorativeness; easy to deep draw
16. Clip	Grade C phosphor bronze	Resilience, ductility
17. Clutch	Type 304 stainless steel	Resilience, chemical resistance
18. Inner cap	ABS copolymer	Tough, chemical resistance, compatibility with collector shell material
19. Clip screw	Free-machining brass	Easy to machine and plate
20. Disposable cartridge shell	High density polyethylene	Low moisture vapor transmission rate, high impact strength, chemical resistance
21. Disposable cartridge plug	Low density polyethylene	Easy to puncture; chemically resistant



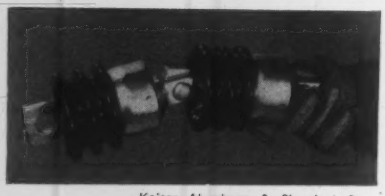
***Refillable unit** (bottom) can be interchanged with the disposable ink cartridge (center) with no modification of the pen's appearance.*

Aluminum Lightens Power Lines

Aluminum Co. of America

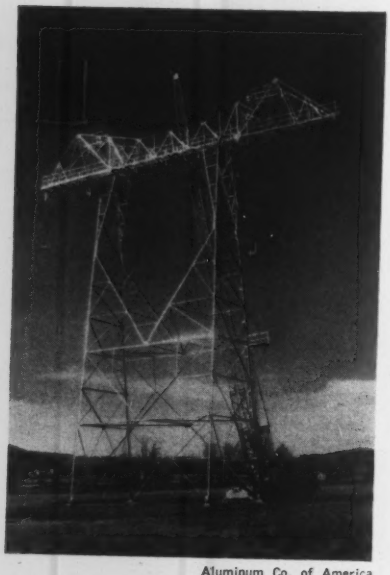
Aluminum is playing an important role in the development of extra-high-voltage transmission lines (460-750 kv). The lightweight metal is used for oversize cables that carry greater electrical loads without creating radio interference. It is also used for supporting towers, lightning rods and accessories. Here are some of the applications in two experimental networks.

Installing 460-kv cables *in Pennsylvania Electric Co.'s 13-mile pilot system. The conductor is a bundle of 1.75-in. dia, steel-reinforced aluminum conductors. Conductors, deadends, armor rods and spacers are all made of aluminum.*



Kaiser Aluminum & Chemical Corp.

Deadend insulator *made with forged aluminum is 30% lighter than previous iron units. The superior corrosion resistance of aluminum in the clevis cap and tongue stud also increases service life of the units sold by A. B. Chance Co.*



Aluminum Co. of America

Transmission tower *of aluminum is the first of its kind to be installed in General Electric Co.'s system near Pittsfield, Mass. The 105-ft tower weighs only 11,400 lb as against 30,400 for a comparable steel tower.*

Aluminum Co. of America

Substation structure *of the Pittsfield system is also aluminum. In addition, the system uses 40-ft high aluminum lightning arrestors on the line.*

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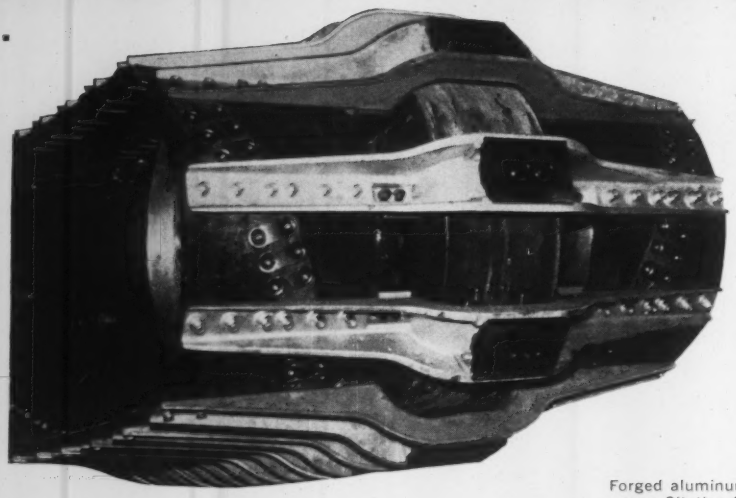
Award-winning entries will be published in the April 1962 Design Engineering Show issue of MATERIALS IN DESIGN ENGINEERING. Some nonwinning entries will also be published in subsequent issues and paid for at the usual rate.

LAST YEAR . . . . . .



Forged aluminum track bar won a Citation for C. J. Nuttall, Jr., and the Engineering Group at Wilson, Nuttall, Raimond Engineers, Inc.

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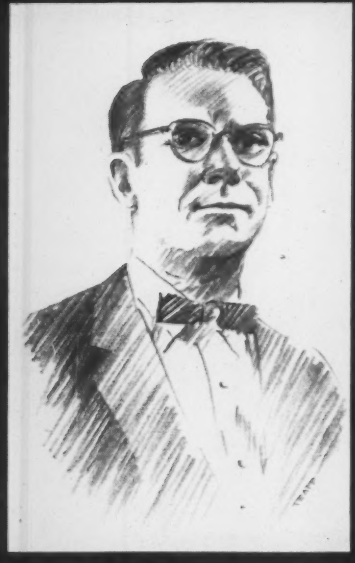
Research and Development
AMERICAN MACHINE AND METALS, INC.

W. A. STADTLER

Director of
Manufacturing Research
INTERNATIONAL BUSINESS MACHINES CORP.

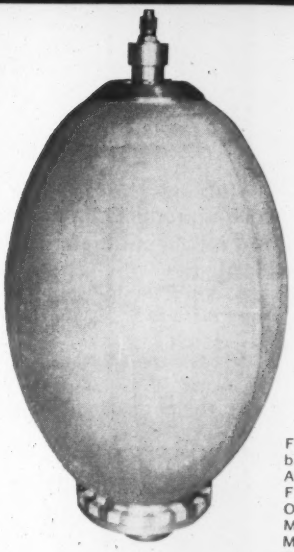
C. E. ARNTZEN



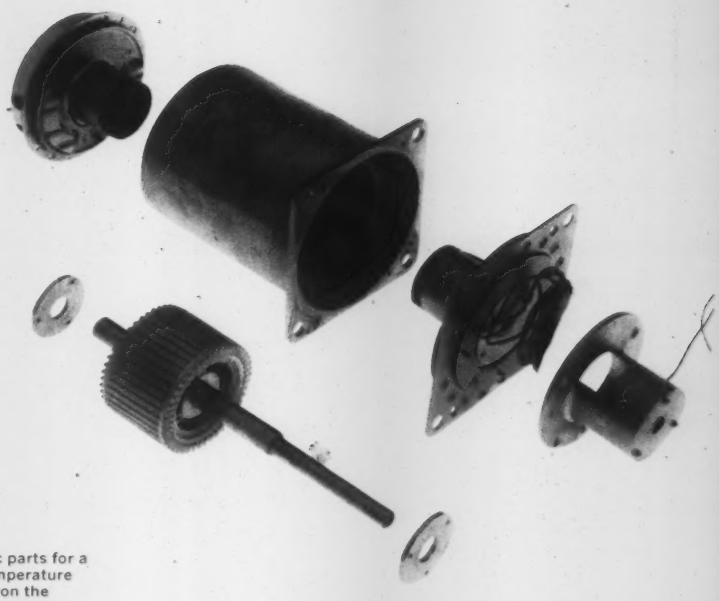
Director
Materials Laboratories
WESTINGHOUSE ELECTRIC CORP.

W. B. GROSS

Chief Production Engineer
A. C. GILBERT CO.



Fluorosilicone fuel bladder won an Award of Merit for F. E. Clark, O. Markles and M. Clancy of the Material and Process Section, North American Aviation, Inc.



Ceramic parts for a high temperature motor won the First Award for R. H. Schmitt at AiResearch Mfg. Co., Div. of The Garrett Corp.

it's easy for you to enter... simply follow these steps

1. **Select your best work of 1961.** You can enter any part or product which you worked on, provided that: (1) you are employed in the product manufacturing industries, and (2) the design was completed during 1961 or the product went into production during 1961. An entry may be either a new product or a redesigned product that demonstrates sound, imaginative and progressive use of engineering materials. Engineering materials are defined as metals, nonmetallics, finishes and coatings, and material forms (such as castings, forgings, moldings, etc.). The product may be a complete assembly, a subassembly, a single part or a component.

2. **Prepare your entry—it's easy.** You need not write up your entry in the form of an article. Entries will not be judged for literary quality. See back page of this folder for details on the information that must be submitted with each entry.

3. **Send in your entry by January 15.** Entries must be mailed no later than January 15, 1962. Mail all entries to Awards Editor, MATERIALS IN DESIGN ENGINEERING, 430 Park Ave., New York 22, N. Y.

The photos above show three of last year's winning entries. The other 13 winners were:

P. A. Lee, Planet Products Corp.

P. Hines, New England Instrument Co.

J. Koziarski, Denver Div., and P. Dick, Nuclear Div., The Martin Co.

M. H. Riesgraf, Aeronautical Div., Minneapolis-Honeywell Regulator Co.

Employee Activities Committee, The Barden Corp.

C. Schroeder, Boeing Aircraft Co.

G. L. Branch and R. Y. Scapple, Materials and Processes Section, Hughes Aircraft Co.

G. E. Sutila and J. F. Goodwin, Aerophysics Laboratory, Douglas Aircraft Co., Inc.

T. F. Bellinger and L. A. Burton, Allis-Chalmers Mfg. Co.

D. R. Kerstetter, Materials Engineering Dept., Electronic Tube Div., Sylvania Products Inc.

R. F. Howard, Materials and Processes Group, Bell Helicopter Co.

E. H. Anderson and C. F. Heidorn, Anderson Controls Inc.

H. F. Everett, The Foregger Co., Inc.

ENTRY FORM

Materials in Design Engineering
A REINHOLD PUBLICATION

6th Annual Awards Competition
for the Best Use of Engineering Materials

Eligibility

Any person(s), department, group, or organization in the product manufacturing industries may submit an entry or entries. No one employed by a materials producer or supplier is eligible.

Preparation of Entries

1. The following information must be provided with each entry in order to allow the judges to make competent decisions:

a. A detailed description of the product, including photographs or drawings. If the entry is a redesign, provide before and after illustrations if possible.

b. A description of requirements in service and/or fabrication that must be met by the product and the material.

c. A description of the previously used materials (if entry is a redesign).

d. A description of the material or materials selected for the product entry.

e. An explanation of why the material or materials were selected for the product. Describe the advantages or benefits gained through the choice. **Back them up with evidence—facts, data, charts, tables on performance, quality or cost.**

In general, entries should show that the materials selected for the product—

- Resulted in improved performance
- and/or lower costs
- or Best met the design and service requirements.

Remember! The more detailed and documented your entry, the more consideration it will receive from the judges.

2. Entries or portions of entries and samples will not be returned unless requested. Entries should not include valuable papers or other material which must be returned, because there is always some danger of loss or mutilation. Whenever possible, photostats, photographs, or other copies of such materials should be used instead.

3. All entries must be postmarked not later than January 15, 1962. The judges reserve the right to withhold awards at their discretion.

Publication of Entries

MATERIALS IN DESIGN ENGINEERING plans to publish articles on the winning entries and reserves the right to publish articles based on entries not winning awards.

Here are a few ways in which a product can benefit from intelligent materials selection:

Long service life

Lower basic materials cost

Less material required

Improved appearance

Permitted a new design

Reduced production costs

Improved service performance

Reduced scrap

Reduced or eliminated maintenance

Permitted lower cost design

Allowed greater design flexibility

Simplified production and fabrication

entry form

Mail to: Awards Editor, MATERIALS IN DESIGN ENGINEERING, 430 Park Ave., New York 22, N. Y.

Name _____ Title _____

Name(s) of person(s), group or company who would receive award _____

_____

Company _____

Street address _____ City _____ State _____

Name or brief description of product being entered _____

_____

Was design (or redesign) of entry either completed or placed in production during 1961? _____

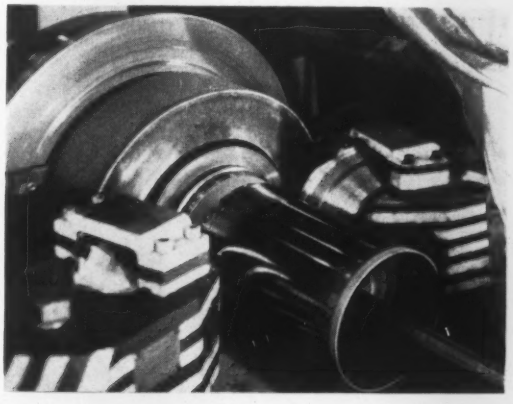
Does your employer consent to entry under terms of this competition? _____

NOTE: Please observe the rules given above. Use a separate blank for each entry; additional entry blanks available on request. Attach entry blank, or its equivalent, to your entry.

New Ways to Strengthen Metals

by Donald Peckner, *Associate Editor, Materials in Design Engineering Manual No.* **188**, *October, 1961*

Ausforming a solid fuel rocket motor case by hot spinning. (GE)



■ Let us begin by admitting that there are no new ways to strengthen metals. As Dr. Paul Flinn of the Westinghouse Research Laboratories has remarked: "Most of these techniques have been known for a long time. But nowadays we are gaining an understanding of the underlying physical principles so that they can be applied more effectively by new techniques and to new materials." ■ So the five ways to harden, or strengthen, metals with which we will be concerned here are new, not in principle, nor even necessarily in application, but new in the importance they are beginning to have in today's engineering world. ■ Probably every engineer, even if he has never been in a heat treating shop, can visualize the quench and temper process which produces a metallurgical transformation from one phase to another. Unfortunately this traditional treatment is not enough for metals that have to maintain strength in the face of the high temperatures encountered in modern aircraft, rockets and missiles, and other advanced equipment. Thus, we have had to develop more sophisticated techniques: Precipitation Hardening . . . Order-Disorder Transformation . . . Strain Hardening . . . Solid Solution Hardening . . . Dispersed Phase Hardening. ■ In many designs, of course, strength is not the sole criterion for selection. For one thing, too high a strength level may leave you with a material that cannot be fabricated. Or strength may have to be paired with another, equally desirable property such as electrical conductivity. ■ Our aim here, then, is to put into perspective these advances in strengthening that metallurgists have made in recent years. Some of these advances are still virtually laboratory curiosities. But others are used every day to produce stronger metals and alloys.

THE OLD QUENCH AND TEMPER . . .

Phase transformation

Still by far the most important from a tonnage standpoint.

Heat to dissolve all alloying elements in a single high temperature phase.

Cool rapidly, transform high temperature phase to various room temperature phases.

Temper to reduce the quenching stresses in the room temperature phase.

THE FIVE 'NEWER' WAYS . . .

1 Precipitation Hardening

The most important way to develop high temperature strength

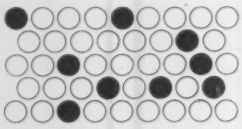
Heat to dissolve all atoms in matrix.

Cool rapidly, retain the supersaturated high temperature structure.

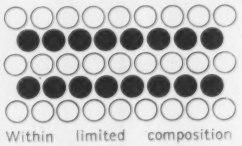
Age to precipitate the solute atoms from supersaturated matrix.

2 Order-Disorder Transformation

Most potent method and one with greatest potential if ductile alloys can be developed



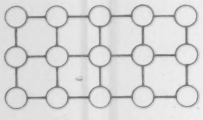
If composition is not correct, or temperature is too high, atoms are arranged at random.



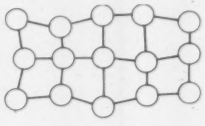
Within limited composition ranges below a critical temperature, atoms have a regular, predictable arrangement.

3 Strain hardening

Principal way to strengthen refractory metals



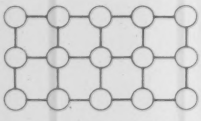
Normal metal crystal lattice.



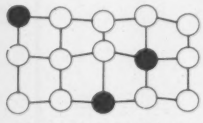
Strained metal lattice is distorted, movement of dislocations impeded.

4 Solid solution hardening

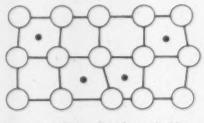
Offers structural stability after long-time elevated temperature exposure



Base metal crystal lattice.



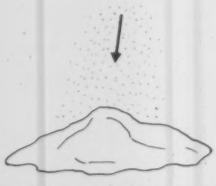
Substitutional solid solution. Foreign atoms take over lattice position of a base metal atom. Lattice is distorted.



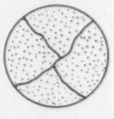
Interstitial solid solution. Foreign atoms occupy space between base metal atoms and distort crystal lattice.

5 Dispersion hardening

For remarkable increases in strength and stability



To a metal powder add a dispersoid (oxide, intermetallic compound, wire, whiskers) by oxidation or mechanical mixing.



Obtain a metal with dispersoid uniformly distributed through the matrix.

1. Precipitation Hardening

The majority of iron, cobalt and nickel-base superalloys are strengthened by precipitation hardening. This makes the method one of the most important today in achieving strength at elevated temperature.

Precipitation hardening is achieved by a two-step heat treatment.

1. Solution treating, or heating the alloy above the solvus line, i.e., the limit of solid solubility, to put all of the alloy constituents into solid solution. The alloy is held at the solution treating temperature for a suitable period and then cooled rapidly to retain the elevated temperature structure.

2. Aging, or precipitating a second phase from the super-saturated solid solution produced by solution treating. Aging is usually done above room temperature to speed up the reaction.

For this heat treating sequence to work, the elements alloyed with the base metal must be more soluble at elevated temperatures than at lower ones. The hypothetical equilibrium diagram shown in Fig 1 illustrates how the position of the solvus point shifts with decreasing temperature.

Coherent precipitate needed

Precipitation hardening works because it interferes with slip in metal crystals and, therefore, strengthens the metal. Dislocation theory, now broadly applied by physical metallurgists, provides a reasonable answer why. Dislocations moving along a slip plane are stopped—or obstructed—by coherent precipitates, i.e., precipitates not separated from the matrix by a grain boundary.

Even though an alloy system meets all the requirements for precipitation hardening, if the precipitate is not a coherent one strengthening will not result. Strains surrounding a coherent precipitate particle (see Fig 2 extend into an appreciable volume of the matrix; incoherent particles affect a much smaller volume. The greater possibility of the coherent precipitate stopping a dislocation moving along a slip plane is apparent.

TABLE 1—COOLING RATE IMPORTANT IN PRECIPITATION HARDENING*

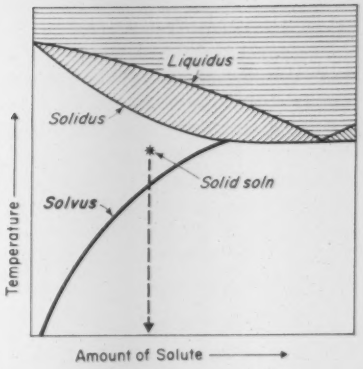
Cooling Medium ↓	Vickers Hardness No.	
	As Quenched	After Aging
Water	57	145
Oil	56	142
Air Stream	66	140
Still Air	74	133
Furnace	76	118

*For Cu + 0.6% Cr, aged 90 min at 530 F. Source: Newkirk.

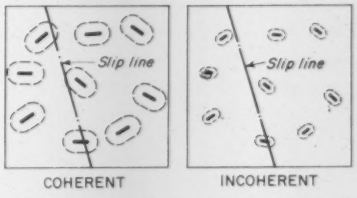
For maximum results

There are a number of ways to increase precipitation rate and distribute the precipitate more uniformly throughout the metal matrix:

- Use an alloy system composed of widely dissimilar metals, i.e., those whose atomic size differs considerably.
- Develop an optimum solution treating temperature, within practical limitations, for each alloy.
- After solution treating, cool as rapidly as possible to avoid premature precipitation. Even so, some precipitation always occurs when quenching from the solution treating temperature. Table 1 indicates that as quenching rate increases as-quenched hardness decreases but maximum hardness after aging increases.
- Control aging temperature and time to prevent under or over-aging with consequent loss of strength. Keep in mind that precipitation rate increases with increasing aging temperature.
- Cold work before aging. This results in a more uniform distribution of precipitate within the grain, markedly increasing mechanical properties. Fig 3 shows how cold work ranging from 0 to 75% increases the hardness (and hence strength) of a copper-nickel-manganese alloy.



1—*Equilibrium diagram for a hypothetical precipitation hardening alloy shows how solvus point, the limit of solid solubility, shifts to the left as temperature drops.*



2—*Strained area (inside dotted lines) is much larger for coherent precipitate shown on left and results in more interference of slip lines.*
(Lund and Drennen)

Heat resistance improved . . .

Room temperature properties of precipitation hardened alloys are competitive with those of alloys strengthened by phase transformation, but the accent today is on extension of strength at elevated temperatures. Precipitation hardened superalloys have usable mechanical properties at temperatures 800 to 1000°F beyond the range of heat treated steels.

Precipitation hardening stainless steels such as 17-7PH, 17-4PH or AM-355 do not follow this rule. They develop superior room temperature mechanical properties by precipitation from a martensitic matrix but are limited to service below about 1000 F where overaging and softening of the martensite begins. However, precipitation hardenable iron-base alloys have been developed for high temperature service, e.g., A-286.

Table 2 shows how rupture strength—an important criterion

of ability to carry loads at elevated temperatures—varies both with temperature and metal. Note how the metal bases change as temperature increases. At 1000 F precipitation hardening stainless steels give way to other iron-base alloys which are superseded at 1300 F by nickel-base alloys. Above 1800 F the nickel-base alloys are superseded in turn by the cobalt-base alloys.

. . . but there is a limit

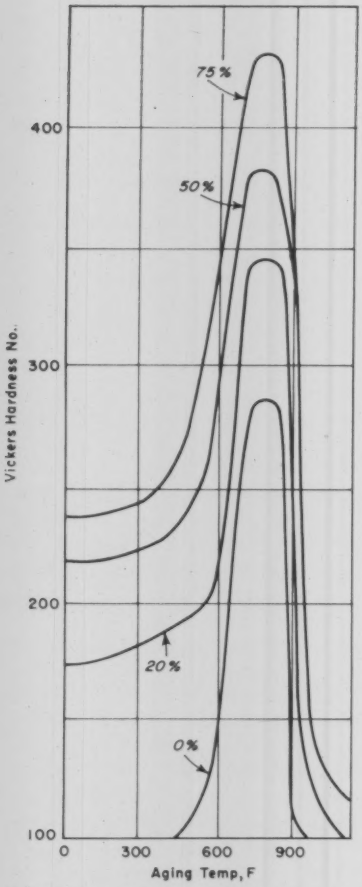
Although precipitation hardening induces many property changes, the rupture data alone are sufficient to point out the importance of this strengthening mechanism.

As its solvus temperature is approached, a precipitation hardening alloy loses strength. To provide strength above the solvus temperature of these iron, cobalt and nickel-base alloys, different alloys, strengthened by solid solution hardening, strain hardening or dispersion hardening, are required.

TABLE 2—STRESS TO RUPTURE SOME PRECIPITATION HARDENING ALLOYS IN 100 HR (1000 psi)

Temp, F ➡	600	700	800	900	1000	1200	1350	1400	1500	1600	1700	1800
IRON-BASE												
Plain Carbon Steel (0.27-0.58 C)	—	70	—	—	10.5	—	—	—	—	—	—	—
17-4 PH	154	134	130	81	—	—	—	—	—	—	—	—
A286	—	—	—	—	100	63	—	28	—	—	—	—
NICKEL-BASE												
Rene 41	—	—	—	—	—	92	66	—	40	26	—	—
Waspaloy	—	—	—	—	—	110	80	—	40	25	—	—
COBALT-BASE												
Haynes Stellite 21	—	—	—	—	—	51	36	—	24	16.7	—	9.4
Refractaloy 80	—	—	—	—	—	—	—	—	18	13	—	7.6

Sources: A. J. Lena, F. S. Badger, C. G. Bieber, and ASTM STP 160.



3—*Cold work before aging increases hardness (and strength). Curve is for a copper alloy containing 30% nickel-manganese.* (Newkirk)

2. Order-disorder

Although ordering is important for magnetic materials, ordered structural alloys have not yet found applications because of their brittle nature. Yet, the atomic bonding forces of ordered alloys are so very much stronger than the valence type of bonding normally found in metals that we should expect ordered alloys to become increasingly important in the future.

In an ordinary solid solution, different types of atoms are arranged at random on the atomic positions of the lattice. In some solid solutions, however, atoms of one kind can be made to segregate on one set of atomic positions leaving atoms of the other kind to the other positions (see p 116). These ordered alloys can be described as a lattice of A atoms interpenetrating a lattice of B atoms.

Ordering depends on both composition and temperature. Not every alloy system has ordered structures; in those that do, the ordered alloys are usually found in narrow composition ranges. Above a critical temperature, the ordered alloy transforms to a disordered one.

Potential is high

When an alloy orders, hardness, tensile strength and electrical conductivity increase, and ductility drops. The difficulty in obtaining ductile ordered alloys, as well as the fact that ordering does not occur in all metal systems, has limited the usefulness of ordered alloys.

An unpublished study compared 100-hr creep life of an ordered alloy, VM91 (approx 78% Ni, 11% Al, 11% Fe), with a solid solution alloy (Inconel) and a precipitation hardening alloy (Inconel X550). The ordered alloy was stronger than Inconel at all temperatures and stronger than Inconel X550 above 1800 F.

If a precipitation hardened alloy with an ordered matrix can be prepared it appears that remarkable properties might result.

3. Strain hardening

Strain hardening, which dates back to antiquity, is nevertheless the principal method used to strengthen the refractory metals today.

Limitations imposed both by rolling equipment and the tendency of the refractory metals to oxidize prevent suppliers from economically hot working these metals. Only one facility, In-Fab, is available (see M/DE, Sept '60, p 27) to economically hot work the refractory metals and it operates on a pilot plant basis.

Dislocations blocked

Cold working increases the amount of stress required for slip. This can be related to dislocation theory, since the disturbed metal lattice impedes movement of dislocations. The blocked dislocation can be moved only by increasing the stress. Thus a strain hardened (or cold worked) metal can be subjected to higher stress than its annealed counterpart before deformation occurs.

This fact is of primary importance today in strengthening refractory metals—both the pure metals and the alloys. In the latter case, the effect of cold work, superimposed on the effect of solid solution hardening, results in stronger metal than either treatment alone could produce.

We showed in Fig 3 that strain hardening increases the strength of precipitation hardened alloys. Response of refractory metals to strain hardening varies with the metal.

The alloy Mo–0.5 Ti is substantially strengthened as Fig 4 shows. However, strain hardening two columbium alloys—F-48 and Cb-1Zr—did not produce a similar effect. Compared with recrystallized columbium alloy, i.e., material with a strain-free crystal structure, some short-time strengthening developed but the strength differential became negligible after long-time exposure at 1800 F.

In other words, although strain hardening is an effective and important way to strengthen refractory metals, it is no panacea.

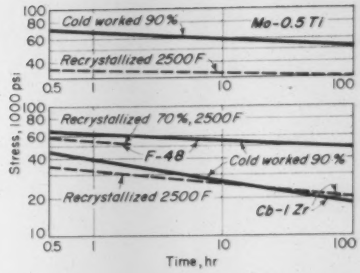
Three new processes

Strain hardening is the underlying factor in three new strengthening methods—ausforming, zerolling and high energy rate deformation. Although laboratory tests prove that these methods greatly improve mechanical properties, industrial usefulness is still being explored. Right now, high energy rate deformation is the most widely used of the three.

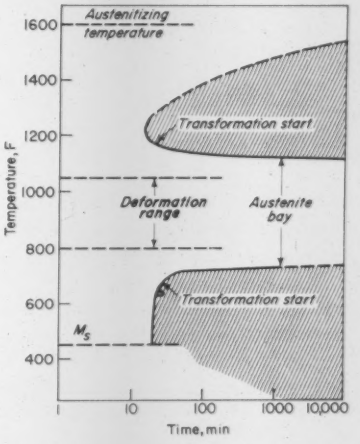
1. Ausforming

The present engineering usefulness of ausforming for strengthening steels has not been fully explored; more research is still needed to make the process a completely practical one from a commercial point of view. A recent M/DE article (Sept '60, p 16) discusses ausforming in detail.

To be ausformed, a steel must have a metastable austenite bay region during isothermal heat treatment, as shown by the hypo-



4—Strain hardening has greater effect on molybdenum–0.5% titanium than on two columbium alloys, F–48 and Cb–1Zr. (Jahnke)

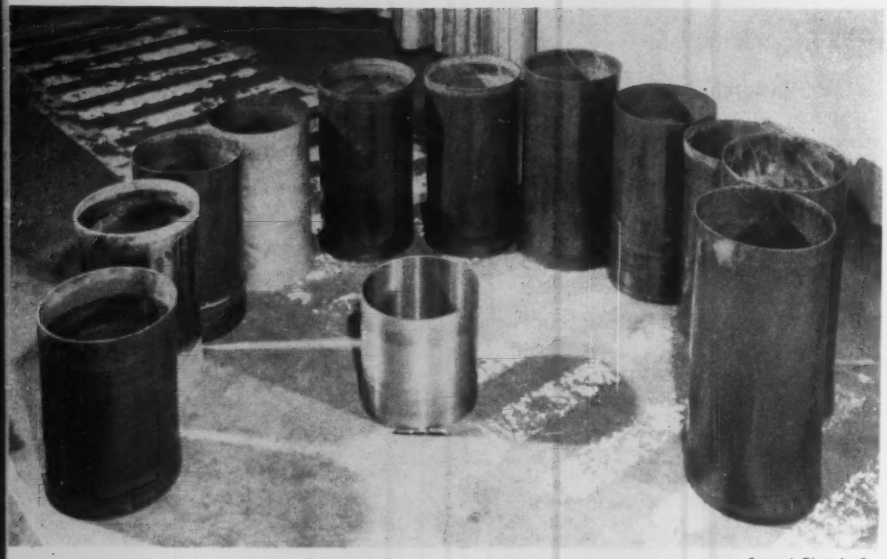


5—Austenite is deformed in the bay region as part of the ausforming process. (Shyne et al)

TABLE 3—AUSFORMING VS CONVENTIONAL HEAT TREATMENT

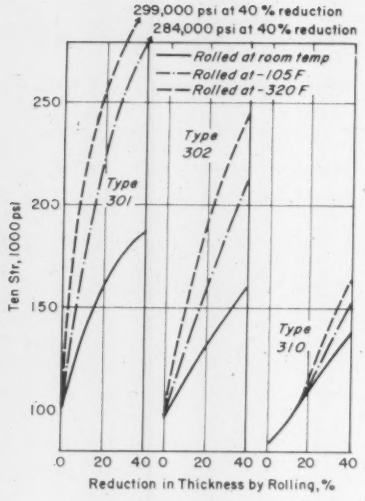
Steel	Deformation			Tensile Strength, 1000 psi		Yld Str (0.2% offset), 1000 psi		Elongation, %		Source[a]
	Percent	Temp, F	Method	Ausformed	Normal	Ausformed	Normal	Ausformed	Normal	
D6A	71	1100	Forged	450	300	325	235	6	10	Ladish
4340	71	1100	Forged	320	275	260	225	5	10	Ladish
V63	90	1000	Rolled	480	335	335	245	8	1	Ford Motor
Halcomb 218	50	900	Spin Formed	384	285	300	225	9	4.5	General Electric
AM-357	85	800	Rolled	285	207	194	145	—	—	Shyne et al.
Potomac A	80	1000	Rolled	315	275	300	215	2	9	Shyne et al.
Type 420 Stainless	75	800	Rolled	340	255	300	190	2	6	Shyne et al.
AM-355	50	1000	Rolled	255	218	245	175	3	19	Shyne et al.

[a]Ladish, Ford, GE data from M/DE, Sept '60, p 17.



General Electric Co.

6—*These solid propellant rocket motor cases were ausformed.*



7—*Zerolling austenitic stainless steels greatly increases tensile strength. (McDowell and Mihalisin)*

thetical time-temperature-transformation diagram in Fig 5. Austenite is deformed within the bay region and then cooled and transformed to martensite.

Steels given this schedule of deformation and transformation are substantially higher in strength than those conventionally quenched and tempered (see Table 3).

There are at least three practical approaches to ausforming that can be applied immediately:

▸ *Rolling*—The most frequently used method, rolling is restricted to simple shapes.

▸ *Forging*—A promising approach, since it is possible to form relatively complex sections that require little subsequent reworking.

▸ *Hot spinning*—This technique has been successfully applied to ausform solid fuel rocket motor cases (see Fig 6).

One disadvantage: fusion welding destroys ausformed properties in the vicinity of the weld deposit and heat-affected zone.

2. Zerolling

Strength of austenitic stainless steel can be radically increased by deforming at subzero temperatures (see Fig 7). Zerolling was discussed recently in M/DE (May '61, p 10) and so will not be discussed at length here.

An important point: no commercial facilities can supply zerolled sheets at this time. One company, Arde-Portland, is using the principle of low temperature deformation to produce stainless steel pressure vessels. They fill the vessel with liquid nitrogen and expand it by pressurizing the liquid with gaseous nitrogen. Cold work introduced by expansion at low temperature strengthens the metal. The company calls its process Ardeform.

TABLE 4—EXPLOSIVE FORMING RAISES MECHANICAL PROPERTIES

Metal	Treatment	Yld Str, 1000 psi	Ten Str, 1000 psi
Iron	Ann.	19	31
	220 kb*	108	123
Steel (0.17% C)	Ann.	35	58
	95 kb	62	72
	220 kb	115	125
Fe–3 Si	Ann	54	74
	95 kb	83	95
	220 kb	140	152
Columbium	Ann.	26	44
	250 kb	47	51
Tantalum	Ann.	28	37
	275 kb	45	48
Austenitic Mn Steel	Ann.	60	130
	100 kb	110	170
	200 kb	125	175

*kb = 1 kilobar or 14,500 psi.
Source: Dieter; Holtzman and Cowan.

3. High energy deformation

Although explosive forming is perhaps the best known high energy deformation technique, two others are also of interest: Dynapak forming and hydrospark forming. Dynapak uses an unbalanced pressure system to deform metals at high, but controllable, velocity. Hydrospark forming discharges a spark in a nonconducting liquid to generate shock waves.

All three methods were fully discussed in a recent M/DE article (July '60, p 89). Since publication of that article, a little more information has been made available about the effects of high energy deformation as a strengthener.

For example, yield strength of three austenitic stainless steels was increased up to 520% after explosive treatment. Table 4 shows explosive hardening effects on six metals.

Changes in mechanical properties correlate closely with those obtained in material cold worked to the same degree.

4. Solid solution hardening

Important in strengthening the refractory metals, solid solution hardening offers structural stability for long-time (over 1000 hr) exposure.

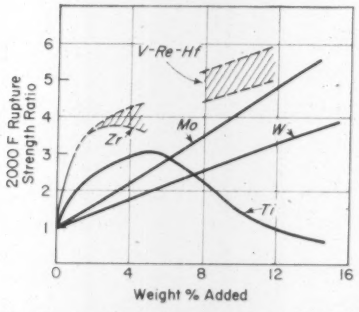
Compared with precipitation or strain hardened metals after less than 1000 hr, a solid solution hardened alloy does not show up too well. Above 1000 hr, however, after the precipitate has begun to diffuse back into the matrix, or the stresses introduced by strain hardening have been reduced, the effect of the solid solution alloying elements is still great.

Forming a complex solid solution containing a large number of elements develops maximum solid solution strength. Strength of a solid solution hardened metal is governed by two general rules:

1. Many elements can be added to a base metal to develop solid solution strength; each element's contribution to strength is very roughly additive. Strengthening occurs only as long as a single-phase solid solution is maintained. If solubility limits are exceeded and a second phase forms, the excess elements do not contribute to alloy strength.

2. Maximum benefits are gained when the atomic size of added elements differs greatly from that of the matrix.

Following these two rules requires careful alloying. Unfortunately, elements that have the greatest atomic size dissimilarity also have the lowest mutual solubility.



8—*Some elements are more potent solid solution strengtheners of columbium than others. Curves are for columbium containing 0.003 to 0.01% carbon and 0.015 to 0.03% oxygen. (Jahnke)*

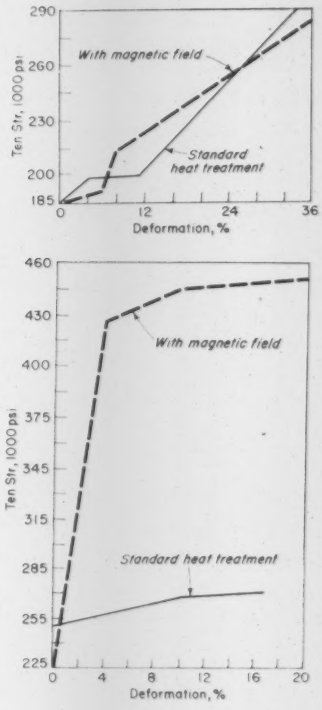
Lattice dimensions changed

Introducing dissimilar atoms forces the crystal structure of the base metal to either expand or contract. This change in lattice dimensions sets up small areas of localized strains around each solute atom that retard the movement of dislocations and thus strengthen the metal.

Today's columbium alloys are solid solution strengthened because strain hardening and precipitation hardening have not been able to raise their strength sufficiently. Molybdenum-base alloys have not used this approach so far because it has not been needed (see Fig 4). Nonetheless, molybdenum alloys can be solid solution hardened and when these effects are added to those of strain hardening, such alloys will maintain an appreciable strength superiority over columbium alloys.

The relative solid solution effects of various alloying elements on columbium are shown in Fig 8. Looking at three commercial columbium alloys, we can see how they are affected by alloying:

- F-48 is about nine times stronger than pure columbium. The additive effects of the alloys are: 15% tungsten (4×); 5% molybdenum (2.5×); and 1% zirconium (3×).
- D-31 alloy (10% titanium–10% molybdenum) is three times stronger than pure columbium. This value falls between the curves for 10% molybdenum (4×) and 10% titanium (1×).
- F-50 (F-48 + 5% titanium) is six to seven times stronger than pure columbium.



Magnetic Treatment

In spite of claims put forth by various companies, no one is sure yet why heat treating a ferromagnetic material in a magnetic field should affect mechanical properties. The opinion of most experts is that there should be no effect.

Several American companies have claimed that use of a magnetic field significantly raises mechanical properties. What is significant, however, is that the method used is not disclosed and that properties of treated metals ofen do not show the expected increase in strength.

A Russian investigator, Bernstein, claims that heat treatment in a magnetic field orients the grains and subgrains. When combined with some type of working, anisotropy is eliminated and high strength levels are produced.

The two graphs above show his results for technically pure iron (top) and a 0.20% plain carbon steel.

5. Dispersed phase hardening

The newest strengthening technique, dispersion hardening, is a kissing cousin of precipitation hardening and has excited the interest of engineers and designers because of the remarkable increases it develops in both strength and stability.

Because this approach is the newest to be used by metallurgists it will be discussed in more detail than the four previous methods.

Metallurgists divide into two schools of thought concerning what is and what is not dispersed phase hardening (or dispersion hardening). The first group feels that wrought or cast alloys are dispersion hardened when fine particles are precipitated from the matrix. The second group feels that the term "dispersion hardened" should be reserved for alloys to which an insoluble second phase is artificially added. Here we will adopt the views of the latter group.

Aluminum was first

The discovery that aluminum could be strengthened by a dispersion of aluminum oxide, made in 1946 by Irmann of Aluminium Industries A. G. (AIAG), stimulated interest in dispersion hardening not only aluminum but also other metal systems, i.e., copper, nickel, titanium, etc. Most of the subsequent work has been concerned with strengthening or improving the properties of metal powders, but dispersion hardening of castings has also been investigated.

The original concept of oxidizing the powder has been expanded and now includes hardening by adding insoluble compounds, fine wires and even whiskers. Today, dispersion hardening is being investigated both for metal-oxide systems and for metal composites, i.e., metals to which metal fibers are added.

The common features for all dispersion hardened systems are these: alloys are prepared by powder metallurgy techniques; the dispersed phase is both hard and insoluble; and alloys are consolidated by extrusion or similar high-strain-rate working. The latter procedure consolidates the alloy into a dense structure and also introduces strain energy into the compact.

Stability is improved

Dispersion hardened alloys are remarkably stable compared with their pure counterparts. Fig 9 represents a study of the recrystallization characteristics of dispersion hardened copper alloys. The copper–3.5% Al_2O_3 alloy maintains hardness up to 1860 F, less than 120°F below the melting point of pure copper. The copper-SiO_2 alloys, because of the coarser SiO_2 particle, start to recrystallize (become softer) at lower temperatures.

The benefits gained by extending the service temperature range are obvious. In effect, a new class of materials has been created by using dispersion hardening techniques.

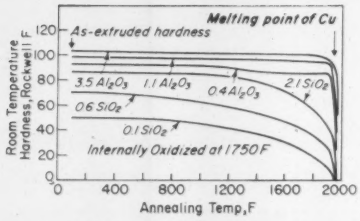
To increase strength

Four factors tend to increase the strength of dispersion hardened alloys:

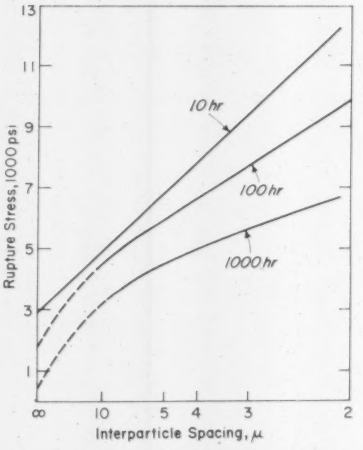
1. Fine interparticle spacing. Fig 10 shows how rupture strength of a series of nickel-aluminum oxide alloys increases as interparticle spacing decreases. This is true for all dispersion hardened alloys.

Fine interparticle spacing (0.2 to 0.3 μ) produces—for a given alloy series—the alloy with the most ductility, the highest thermal and electrical conductivity and, in general, the most metallic behavior.

2. Fine particle size. The same interparticle spacing can be developed with a wide range of particle diameters for the hard dispersed material. As particle size of the dispersed material becomes finer, less material is needed to achieve the desired interparticle spacing.



9—*Stability of dispersion hardened alloys is shown here for copper alloys. Hardness of the alloy containing 3.5% Al_2O_3 is maintained up to 120 °F below the melting point of pure copper. (Grant)*

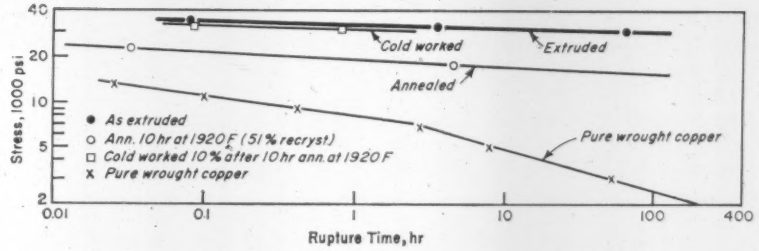


10—*Decreasing interparticle-spacing raises the rupture strength of dispersion hardened alloys. (Grant)*

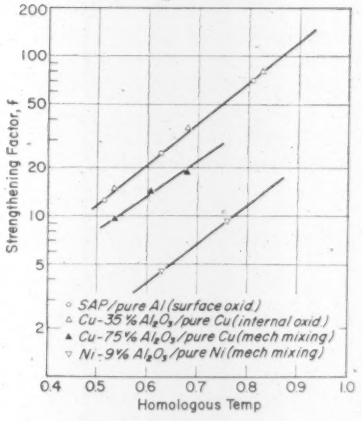
3. Inertness of the hard particles. The least soluble, most refractory dispersion agent produces the most stable alloy. Refractory oxides offer the best potential although other intermetallics, such as $Al Fe_3$, have been used.

4. Cold working the alloy. Fig 11 shows that the strength of an internally oxidized copper–1.1% Al_2O_3 alloy, as extruded, is substantially higher than that of the annealed alloy. Cold working the annealed specimen 10% increased the strength almost to the as-extruded level.

Cold working the matrix, combined with the dispersion of fine particles, impedes dislocation movement and strengthens the dispersion hardened metal.



11—*Cold working by extrusion is one factor in increased strength of dispersion hardened copper-1.1% Al_2O_3 over wrought copper. Annealing reduces strength but additional cold work raises it almost to original level.* (Grant)


Strengthening Factor, f
Homologous Temp
SAP/pure Al (surface oxid)
Cu-35% Al_2O_3/pure Cu (internal oxid)
Cu-75% Al_2O_3/pure Cu (mech mixing)
Ni-9% Al_2O_3/pure Ni (mech mixing)

12—*Rupture stress ratio, f, for dispersion hardened vs pure metal shows that either internal or surface oxidation is preferred over mechanical mixing.* (Grant)

Produce dispersions four ways

There are at least four ways to introduce dispersions into a metal matrix, and not all of them give the same results:

1. Surface oxidation of ultrafine powders. This method, used for sintered aluminum powder alloys (SAP), produces a thin oxide skin on the powders which are then compacted, sintered and extruded. The technique is restricted to metals that form a tightly adhering refractory oxide skin. For maximum strengthening, the powder particle should be less than 1 μ thick. A relatively uniform, reproducible structure is achieved.

2. Mechanical mixing of fine metal powders. Metal powders (less than 10 μ dia and, for optimum properties, 1 μ and finer) are blended with much finer metal oxide powders. The ratio of dispersed phase diameter to metal diameter should be 1:30 to 1:250 in order to properly distribute the dispersed phase; adding too much oxide causes segregation. The normal sequence is to add 0.5 to 0.15% by volume; this produces a series of alloys with increasing strength and decreasing ductility.

3. Internal oxidation of dilute solid solution alloys. These systems consist of a relatively noble metal matrix and a readily oxidizable solute element. The method is only of value when the free energy of formation of the oxide is relatively low compared with that of the solute element. Fineness of the resulting particle is determined by three factors: difference in free energy, temperature of oxidation and diameter of the starting powder.

4. Direct production from a liquid metal. Liquid metal is quenched and atomized to produce the powder. This method requires an alloying element that is soluble in the metal and relatively insoluble in the solid. As solubility decreases, the structure becomes more stable at elevated temperatures. An advantage of this method is that it produces coarse powders. These are easier to handle than the fine powders normally specified for the three preceeding methods.

Fig 12 compares the degree of strengthening of alloys dispersion hardened by the first three methods with untreated metal, on the basis of an "f" factor, i.e., the ratio of stress for 100-hr life of the dispersion hardened alloy relative to the untreated metal. A homologous temperature scale (ratio of test temperature to absolute melting temperature) is used to compare the different alloys.

From Fig 12 it is apparent that the surface and internal oxidation techniques produce alloys superior to ones mechanically mixed. The superiority is related to interparticle spacing (see Fig 10) which is greater for the mechanically mixed alloys by a factor ranging from 3 to 10.

In all probabilty, as finer powders become available, the "f" factor for mechanically mixed alloys can be expected to increase.

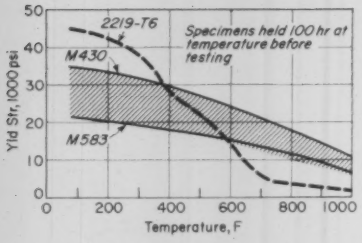
Seven metals: strength boosted

In general, mechanical properties of dispersion hardened alloys, other than ductility, are superior to those of the base metal. In some cases, however, this superi-

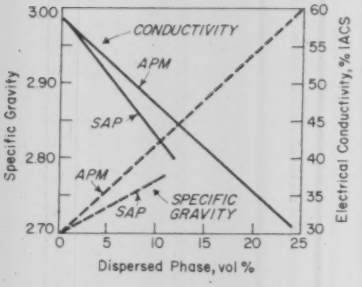
TABLE 5—CHEMICAL COMPOSITION OF SEVEN DISPERSION HARDENED ALUMINUM ALLOYS

Alloy		Powder Type	Nominal Composition, %							Vol Dispersed Phase, %
Alcoa	AIAG		Al_2O_3	Fe	Ni	Cr	Ti	V	Zr	
M257		Milled	6	—	—	—	—	—	—	5
M583	SAP930	Milled	7	—	—	—	—	—	—	6
M470	SAP895	Milled	10	—	—	—	—	—	—	8
M430	SAP865	Milled	14	—	—	—	—	—	—	11
M486		Atomized	0.5	7.3	—	0.2	0.2	0.2	0.2	15[a]
M643		Atomized	0.5	5	7	0.2	0.2	0.2	0.2	29[b]
M457		Atomized	0.5	0.5	1	—	—	—	—	3[b]

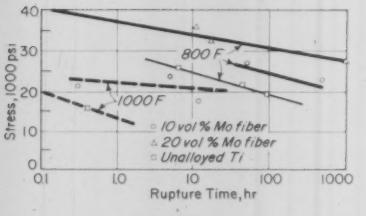
[a] $FeAl_3$ [b] $FeNiAl_9$
Source: *Towner.*



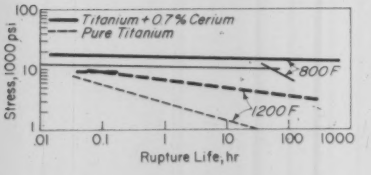
13—*Dispersion hardened aluminum alloys are stronger above 600 F than one of the strongest wrought alloys, 2219-T6.* (Towner)



14—*Volume of dispersed material affects specific gravity and electrical conductivity of dispersion hardened aluminum alloys.* (Towner)



15—*Titanium reinforced with discontinuous molybdenum fiber is significantly stronger than the unalloyed metal.* (Holladay)



16—*Dispersion hardened Ti–0.7% CeO_2 alloy is significantly stronger than pure titanium. Straight slope of curve indicates a stable metal-oxide system. Note how curve for pure titanium at 800 F breaks after 50 hr.* (Hiltz)

ority is not evident until some elevated temperature is reached. The particular advantage of dispersion hardened alloys over precipitation hardened alloys—stability at higher temperatures—is most often demonstrated by improved stress-rupture properties.

Here are the results of studies made on seven metals:

1. Aluminum

There are two groups of commercial dispersion hardened aluminum alloys: the original AIAG alloys, popularly called SAP alloys, and those developed by the Aluminum Co. of America, designated APM alloys. Compositions are shown in Table 5. SAP alloys are produced by surface oxidation while the APM alloys are produced by atomizing liquid aluminum and forming insoluble intermetallic compounds (see discussion on p 123). The aluminum alloys represent the principal commercial application of dispersion hardening.

Both the SAP and APM alloys maintain usable strength up to 1000 F, compared with 600 F for 2219-T6, a high strength wrought aluminum alloy. Fig 13 shows how yield strength varies with temperature. The ductility of any of the APM or SAP alloys above 600 F is lower than that of 2219-T6 (15% vs approximately 25%).

Fig 14 relates specific gravity and electrical conductivity for both types of alloys. You can use Table 5 to check volume of dispersed phase and determine the properties of the individual alloys.

2. Copper

Two previous graphs (Fig 9 and 11) show conclusively that copper with various hard particle additions is significantly stronger than pure copper and resists softening at temperatures up to 1500° F above the softening point (recrystallization temperature) of pure copper. As Fig 9 indicates, dispersion hardened copper alloys can, in some cases, be used at temperatures just below the melting point of pure copper.

Since many applications depend on the high electrical conductivity of copper, it is interesting to note that the conductivity of copper base dispersioned hardened alloys is 87 to 93% IACS.

3. Titanium

Titanium has been dispersion hardened in two ways: by adding molybdenum fibers (both continuous and discontinuous) to the matrix and by introducing insoluble refractory intermetallics. Both techniques produce superior properties compared with normally treated titanium.

Fiber-reinforced — Reinforcing unalloyed titanium with continuous molybdenum wire improves tensile strength at all temperatures up to 1400 F. In one test, tensile strength of unalloyed titanium was approximately 10,000 psi at 1200 F, whereas the tensile strength of titanium–12.6 vol % molybdenum fiber was approximately 22,000 psi at 1200 F and 17,000 psi at 1400 F. The titanium–61.2 vol % fiber exhibited a tensile strength of 60,000 psi at 1200 F. Strength of the latter alloy, however, is probably related more closely to the high molybdenum content than to fiber reinforcement.

Careful preparation is needed to reinforce titanium with continuous molybdenum fibers. Use of discontinuous fibers that can be added to the powder is more closely related to powder metallurgy processes and of more practical interest to engineers at this time.

Tests on Ti-6Al-4V showed that composites containing 30 to 40 vol % discontinuous molybdenum fibers at 1200 F are as strong as unreinforced Ti-6Al-4V at 800 F. Between 1000 and 1400 F, the fiber-reinforced composites are stronger than arc melted Ti-7Al-3 Mo and Ti-6Al-4Mo and comparable to the precipitation hardened iron-base superalloy, A-286. On a strength-to-weight basis, fiber-reinforced Ti-6Al-4V is superior to A-286.

Stress-rupture properties, a more important measure of load-

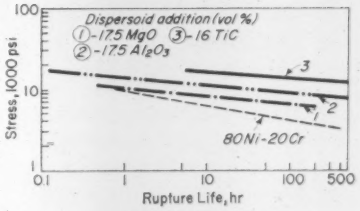
carrying ability than tensile strength, also are improved by fiber reinforcement, as Fig 15 indicates.

Modulus of elasticity of unreinforced Ti-6Al-4V is 10×10^6 psi at 1000 F. At 1300 F, moduli are 16.7×10^6 psi, 18.5×10^6 psi and 23.8×10^6 psi for 20, 30 and 40 vol % reinforcement, respectively.

One disadvantage: at temperatures over 1200 F, both titanium and molybdenum must be protected from oxidation.

Dispersed particles — Many types of particles have been used to harden titanium. Intermetallic compounds such as Ti_5Si_3, TiC, TiAl and Ti_2Cu, and oxides such as Al_2O_3, MgO, ZrO_2, have been added mechanically to titanium, and Ti_2Cu has been precipitated from solid solution in alloys which cannot be considered in the precipitation hardening group. Internal oxidation to produce a dispersion of CeO_2 has also been studied.

All of the additions improve tensile properties considerably.



17—*Three types of dispersions have different strengthening effects on an 80 Ni-20 Cr alloy. (Gregory et al)*

Unalloyed titanium is generally used as the base for comparison but the data show that dispersion hardened titanium is competitive with or superior to alloys of titanium up to 1200 F.

For example, the Ti–Ti_2Cu alloy, properly treated, has a longer rupture life at 1000 F than the Ti-7Al-3Mo alloy. Rupture life at 1000 F, in hr, is as follows:

Stress, psi	Ti–Ti_2Cu	Ti-7Al-3Mo
60,000	345	62
50,000	695	280

Internal oxidation of cast and rolled titanium-cerium alloys improves stress-rupture strength. Note in Fig 16 how the curve for unalloyed titanium shows a break at 50 hr and 800 F. The flat slope of the rupture life curves for the Ti-0.7% CeO_2 alloy is typical of stable metal-metal oxide alloys and is very desirable in good dispersion hardened systems.

Which is better?—Data developed to date indicate that fiber reinforcement is promising for short-time applications (because of the oxidation problem) but that hardening with insoluble particles may be useful for both short- and long-time improvement at elevated temperatures.

4. Nickel

Dispersion hardened nickel alloys have not been investigated as extensively as those of aluminum, copper or titanium. One study on thermal stability indicated that nickel alloys dispersion hardened with Al_2O_3 began to

Vacuum Melting Methods Are Indirect Strengtheners

Melting practice does not fall within the framework of this article and yet it cannot be passed over lightly. The importance of vacuum melting methods in strengthening metals, however indirectly, is of interest to every engineer who specifies metals.

The three important vacuum techniques are:

Vacuum induction melting. Differs from air induction melting only in operating pressures. Temperatures and working of the melt are identical. Advantages: better control of composition, including modification to obtain greater creep strength; reduction of harmful inclusions to improve forgeability.

Vacuum arc melting. Starting with an electrode, stock is carried across an arc and deposited in a water cooled copper mold. Advantage: controlled solidification to produce an exceptionally sound ingot.

Vacuum degassing. Metal is melted in a conventional furnace and teemed into an ingot mold through a vacuum. Advantages: hydrogen content is reduced; oxidation is prevented.

Many properties improved

Vacuum melted metals fall into two general classes:

1. Those that can be melted by conventional methods. In this case, any improvement can be attributed to the process.
2. Those that must be melted in vacuum because of their composition. Here, material improvements result directly from the composition changes permitted by vacuum melting.

Here is how the properties of six alloy groups are improved by either vacuum melting or pouring.

▸ *Low alloy steels.* Ductility, impact strength and fatigue strength are improved, especially in the transverse direction.

▸ *Bearing steels.* By eliminating nearly all inclusions, vacuum melting more than doubles the fatigue life of AISI 52100 steel. Impact strength is improved slightly.

▸ *Stainless steels.* Transition temperature, rupture strength and ductility are improved.

▸ *Iron and nickel-base superalloys.* Tensile strength, ductility, fatigue strength and stress-rupture properties are improved.

▸ *Cobalt-base superalloys.* Rupture ductility improves but tensile and rupture strengths are not significantly affected.

▸ *Reactive and refractory metals.* These metals must be melted under high vacuum or in an inert atmosphere to prevent gas pickup that drastically reduces all properties.

show a drop in hardness at 2000 F. Other precipitation hardened nickel-base alloys began to lose hardness (or over-age) rapidly at 1340 F. The temperature differential is substantial.

Fig 17 shows how various dispersions strengthen an 80% nickel—20% chromium alloy at 1500 F.

5. Tungsten

Efforts are being made to dispersion harden tungsten in order to increase high temperature strength. Tungsten-thoria alloys, to date, have shown significant improvements over unalloyed tungsten, but no data are available for other alloys.

6. Lead

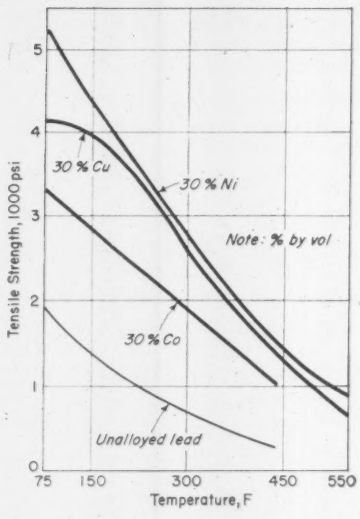
Although not claimed to be dispersion hardened alloys by their developers, lead-cemented alloys meet the standards we have set for dispersion hardening (see p 123). Highly refractory materials are not added to lead, but the metals that are added, such as cobalt, nickel and copper, must have very low solubility and must be wet by the lead.

Lead-cemented alloys do not show the large increases in elevated temperature strength that characterize alloys strengthened by the more commonly accepted methods of dispersion hardening. However, Fig 18 shows that at all temperatures strength is increased over that of unalloyed lead.

7. Silver

The Missile and Space Vehicle Dept. of General Electric Co. has just announced the production of silver reinforced with sapphire whiskers. Tensile strength of the composite is 118, 500 psi—five times the performance of unreinforced silver on a strength-to-weight basis.

Whiskers, which approach calculated theoretical strength more closely than any other form of material, should significantly add to the strength of dispersion hardened alloys if their strength can be maintained. According to GE the sapphire whiskers apparently were not weakened by processing.



18—*Tensile strength of lead-cemented alloys varies with alloy addition.* (*Williams*)

Still being investigated: whisker-reinforced aluminum, steel and refractory metals. The GE development may prove to be a significant breakthrough for dispersion hardened metals.

Acknowledgments

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Dow Corning

SILICONE NEWS

for design and development engineers • No. 87

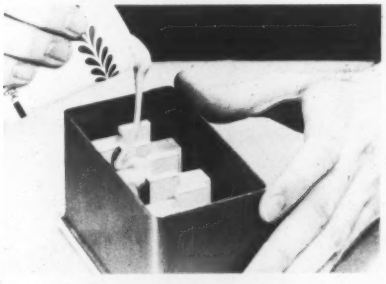
Now: Instant Molds

Think of a silicone rubber you can pour into place to produce flexible molds, to encapsulate electronic assemblies, to make a one-of-a-kind gasket or seal. Think of such a material and you think of Silastic® RTV.

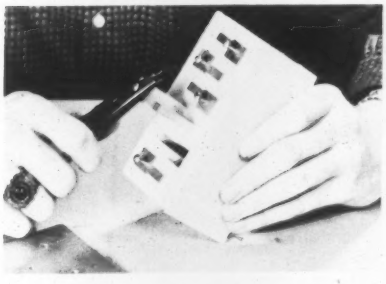
Because it is fluid rubber, Silastic RTV readily flows in and around complex shapes. Once in place, Silastic RTV sets up without heat in a few hours to a solid silicone rubber accurately reproducing the finest detail. It strips readily from the original and you have a flexible mold now ready to receive almost any molding material, even molten metals up to 500 F.

Shallcross Manufacturing Company, Selma, N. C. found it feasible to shortcut production by utilizing Silastic RTV molds when encapsulating electronic components with epoxies. Here's the simple procedure Shallcross followed:

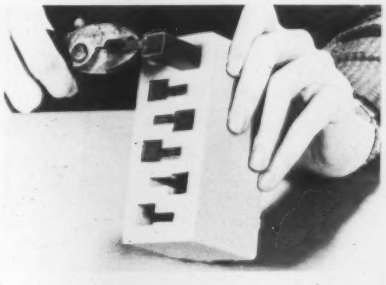
Step. 1. Make the mold. Silastic RTV is poured over the mold forms . . . flows smoothly around the form. Result: a void-free flexible mold that withstands temperatures to 500 F . . . doesn't shrink or distort on aging.

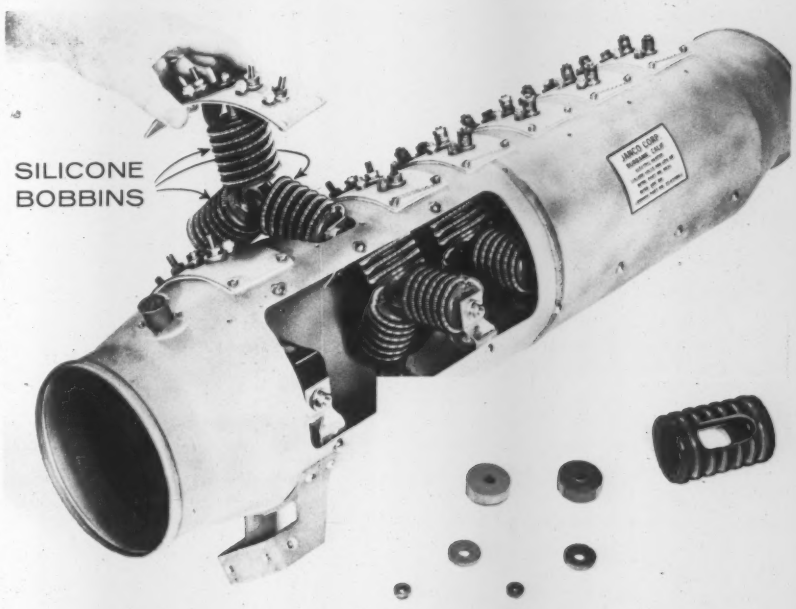


Step 2. Components to be encapsulated are placed in the mold and the material is poured over them. After the encapsulant sets up, parts are ready for removal.



Step 3. Parts release quickly and cleanly from the flexible Silastic RTV multiple cavity form. The form is clean — ready for next use. *(Cont. Pg. 2)*





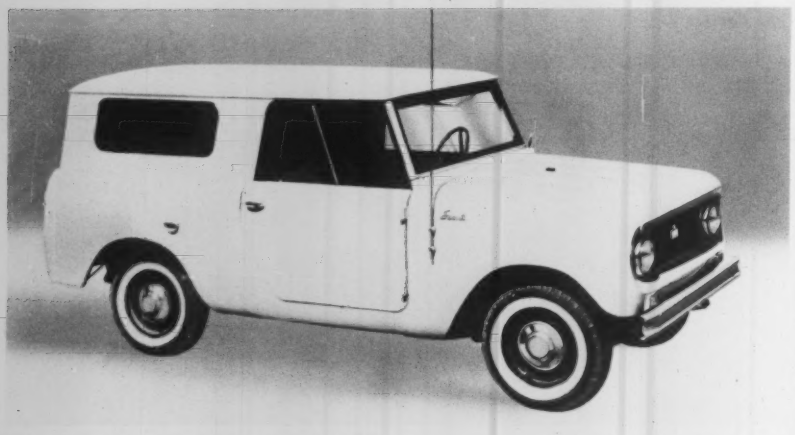
AIR-CONDITIONED HEAT

How to keep a comfortable temperature level in passenger cabins while planes are on the ground? Janco Corporation, Burbank, California, solved this problem for Convair 990's and other aircraft having pressurized cabins by designing auxiliary electrical heaters to be installed directly in the air ducts of the plane's air conditioning systems.

Rated at 15 KW input, 115/200 volts, 400 cps, 3-phase, the space-saving Janco heaters are capable of heating 90 pounds of air per minute at sea level (29.92 inches of mercury) to effect a temperature rise in excess of 45°F. An important key to the efficiency and reliability of these heaters is the inherent toughness of parts made of Dow Corning silicone molding compound.

These parts include 21 coil bobbins on which resistance wire is wrapped to form radiant heater elements and an assortment of 98 washers that secure the bobbins to metal mounts. In actual service, the silicone molding compound parts are exposed to oven-like temperatures that would "wilt" most plastics and are unaffected by rapid temperature cycling that would crack many conventional materials

According to Janco's materials control engineers, the silicone molding compound was specified because (1) this material has superior physical and electrical properties at −67 to 500°F, (2) is easy to mold into complex shapes designed for strength and light weight, and (3) the silicone parts are completely odorless and give off no offensive vapors despite high operating temperatures. Janco molds the parts into finished shapes in a transfer molding machine, post cures them up through 500°F. *(Cont. Pg. 2)*



BUILT TO LAST... AND SELL

A current confirmation of the old adage that "a quality product will always sell" is the Scout all-purpose vehicle manufactured by International Harvester Company. Though the company originally planned to produce only 18,000 units the first year, it topped that mark in July, may turn out as many as 40,000 the first year.

Why is the Scout scoring such a smashing sales success? One answer is its versatility. But another just as important success stimulant is the dependable performance designed into this vehicle by IH engineers. Take the front and rear crankshaft oil seals, for example. In the Scout, they're made of Silastic®, the heat resistant silicone rubber developed by Dow Corning.

Why Silastic? Because Silastic stays rubbery — maintains a positive tight seal capable of taking a beating even when the "heat's on". And it's really "on" when oil temperatures can reach 270-280 F as they may do in the Scout's 4-cylinder Comanche engine. A truly imaginative piece of design engineering, the Comanche is basically the right bank from the 304 cu. in. displacement engine of International Harvester's small V-8 series. Since Silastic oil seals, made by Yale Rubber Co., Sandusky, Michigan, passed all high temperature performance tests and are standard equipment in the small series V-8's, why change?

By the way, these small series V-8 engines power International Harvester trucks at GVW up to 41,000 pounds.

Just as Silastic met the material requirements of this design, it can meet your needs for rubber parts to operate at extreme high and low temperatures. For full information, circle . . . . . *No. 243*

MOLDING COMPOUNDS *(Cont.)*

Dow Corning recently established a special facility to render engineering service to fabricators and end users of silicone molding compounds. The staff at this facility will gladly assist you in getting the most value from thermosetting silicone compounds. For information about this service and silicone compounds, circle . . *No. 241*

INSTANT MOLDS *(Cont.)*

The moldmaking material Shallcross previously employed required a 300 F cure, distorted on aging and cost substantially more. In contrast, Shallcross engineers found Silastic RTV molds are easier to handle . . . have a 400% longer service life . . . don't distort, shrink or alter their shape during storage . . . give finer detail. For information on what Silastic RTV can do for you, circle . . . . . *No. 242*

Announce materials engineering conference

Further evidence of the growing recognition for the importance of materials engineering is found in the announcement that the American Institute of Chemical Engineers will sponsor a day-long materials engineering program during its 1961 annual meeting. Scheduled for December 7 in the Commodore Hotel, New York City, the conference will be open to all interested persons, AIChE members and non-members alike.

Chairman for the AIChE Materials Engineering program is E. G. Bobalek, Professor of Chemical Engineering at Case Institute of Technology. Dr. Bobalek has announced the morning session will feature a panel discussion with the theme "Materials Engineering, the Modern Concept and Present Day Practice". Members of the panel are H. R. Clauser, Editor, MATERIALS in Design Engineering; S. W. Herwald, Vice President, Westinghouse Electric Corporation; G. A. Hochwalt, Vice President, Monsanto Chemical Company; and L. H. Van Vlack, Professor of Materials Engineering, University of Michigan. The afternoon session of the program will be devoted to the presentation of papers by leading aerospace authorities and others in the materials field.

If you're interested in materials or materials engineering, and expect to be in the New York City area at the time of this pace-setting conference, why not plan to attend?

The event:	AIChE Materials Engineering Conference
The date:	December 7, 1961
The place:	Commodore Hotel
The time:	9-11 a.m., 2-5 p.m.

For complete information about the conference, including abstracts of all papers and names of all scheduled speakers, circle . . . . . *No. 244*

Space Age Silicones are described in new brochure containing thirty typical application stories. Utilization of silicone compounds, fluids, lubricants, protective coatings, rubbers, resins, potting materials and sealants are illustrated for your consideration. This valuable brochure offers solutions to many problems encountered in designing space age aircraft and ground support equipment. . . . . *No. 245*

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Melting Points of Refractory Materials

References

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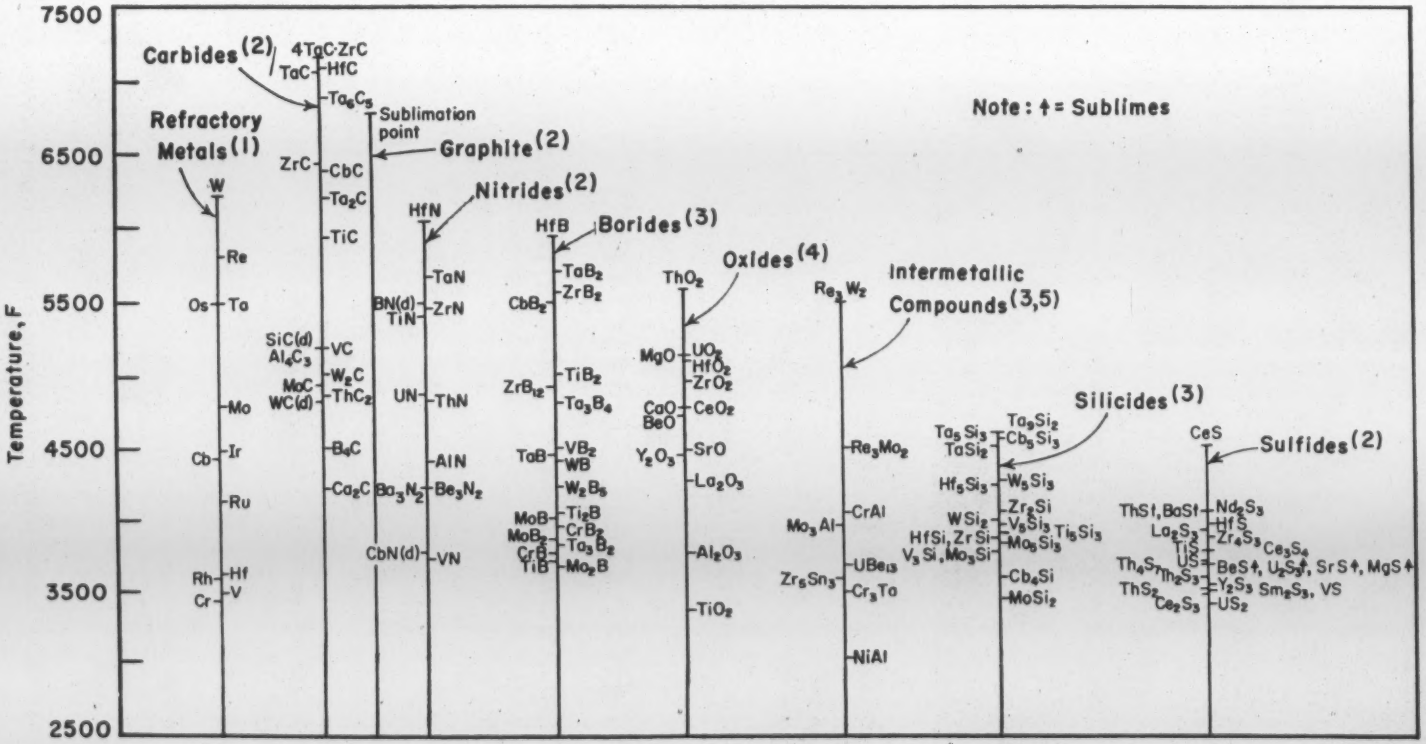
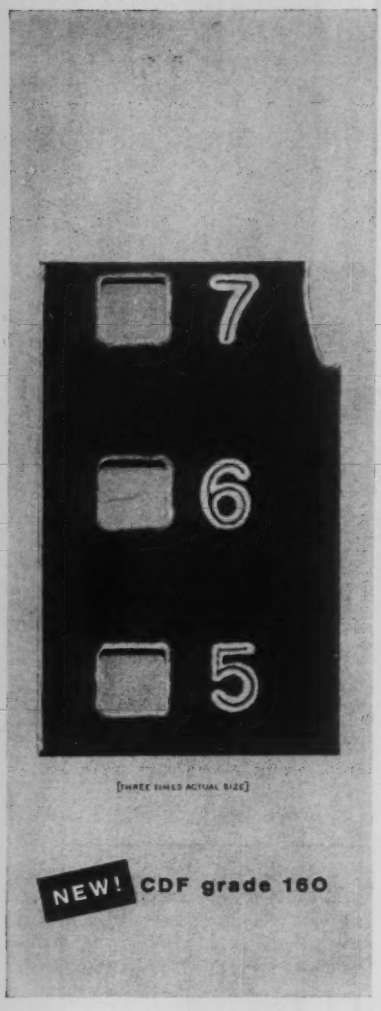


Source: Battelle Memorial Inst., DMIC Memo 44, Feb 26, 1960.



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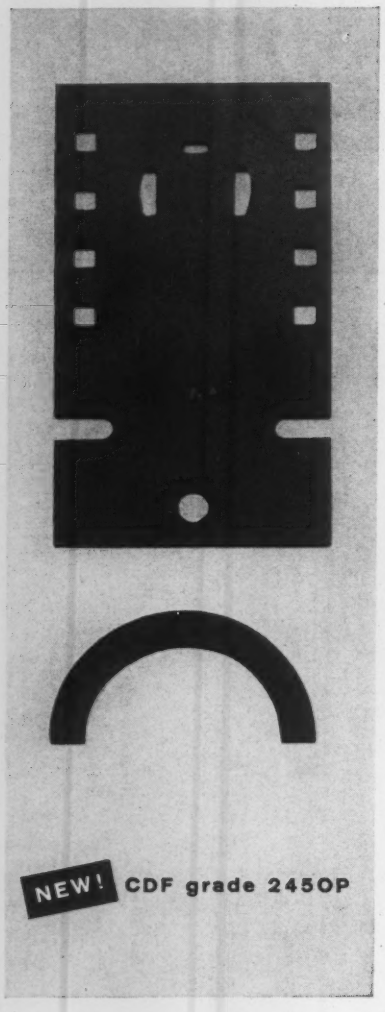
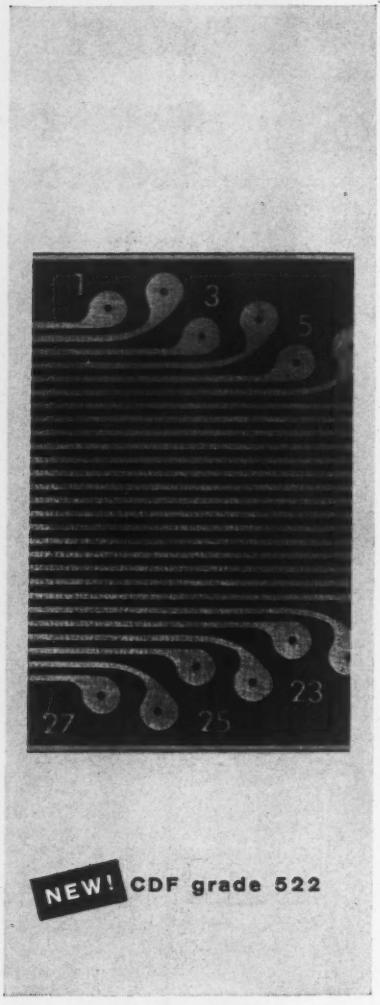


NEW! CDF grade 2450P



NEW! CDF grade 522

three outstanding new laminates!

High legibility letters, numbers or symbols can be stamped on this new warm punch, paper phenolic grade in the same die used for blanking and piercing! No separate operation is necessary . . . no registration problems. Markings are permanent and in sharp contrast. Ideal for capacitor caps, terminal boards, panels, spacers, coil ends, socket bases. Meets NEMA X and XP requirements.

Economical paper phenolic grade 2450P can be punched warm and has improved mechanical strength and lower moisture absorption properties. It is designed especially for mechanical and low voltage electrical insulation applications such as connector blocks, coil and bobbin ends, washers, plug and socket bases. Meets NEMA X and XP requirements.

Excellent wet electrical and other improved properties make this new copper-clad glass fabric Teflon* laminate ideal for radar insulation, missile antennas, critical computer applications. Circuits based on this grade will show minimum drift under varying temperature and humidity. Also available without copper for such uses as high frequency insulation in wave guides.

These are the newest materials of CDF research and engineering, developed to give you outstanding performance at minimum cost. Your inquiry is welcomed.

*Du Pont trademark

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Price of polystyrene has been increased 1¢ per lb by Rexall Chemical Co., Div. of Rexall Drug & Chemical Co. New truckload price for general purpose grade is 19¢ per lb. Dow Chemical Co. and other major polystyrene producers have followed with a similar price increase. Last winter Dow raised its polystyrene price 1¢ per lb (M/DE, Feb '61, p 129) but went back to the original price when other producers failed to follow suit.

Production of tungsten–26% rhenium wire in sizes as fine as 0.0005 in. in dia and in continuous lengths over 2000 ft has been announced by Hoskins Mfg. Co. Short lengths of strip in widths up to 4 in. and in thicknesses down to 0.005 in. are also available.

Availability of a new inductive core material called Supermendur has been announced by Westinghouse Electric Corp. The vanadium-iron-cobalt alloy is available as strip from the company's Materials Mfg. Dept. in Blairsville, Pa. (See p 180 for more details on the material.)

More methyl methacrylate molding powder will be available when American Cyanamid Co.'s new multi-million dollar plant in Wallingford, Conn. begins production in mid-1962. The powder will be produced under a license from Imperial Chemical Industries, Ltd. of England.

Wide sheets of tungsten, molybdenum and other refractory metals will be produced at new facilities now under construction at GE's Lamp Metals and Components Dept. in Euclid, Ohio. One hot rolling mill at the plant is capable of producing 24-in. wide tungsten sheet and plate in thicknesses from 0.150 to ½ in.

Pipe made of Delrin acetal resin will be produced in a new Du Pont plant planned for Tulsa, Okla. The company says the plant will have a capacity of 5 million pounds of oil field pipe per year. It is expected to be in production by next summer.

A 10% cut in the price of beryllium rods has been announced by Brush Beryllium Co. The rods are sold in diameters ranging from ¼ to 6 in.

Eleven wide-flange I-beam sizes have been added to U. S. Steel Corp.'s new product line of rolled structural shapes (M/DE, July '61, p 9). The I-beams, called Carnegie, are made from quenched and tempered alloy steels T-1, T-1 Type A, 9% nickel and HY-80 naval armor steel.

A 2¢-per-lb cut in the price of aluminum ingots has been announced by the major producers. New price: 24¢ per lb.

A complete roundup of current prices appeared in the September issue.

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1961 Metal Show Guide

43rd National Metal Congress and Exposition
Detroit, Oct 23-27

The Technical Program

Ten technical societies are combining their efforts in the 1961 National Metal Congress to present up-to-date information in practically every sector of materials development, processing and application.

Over 200 papers will be given during 68 half-day sessions. The American Society for Metals will sponsor the Congress in cooperation with the Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers, Society for Nondestructive Testing, American Welding Society, American Gas Assn., Industrial Heating Equipment Assn., Metal Powder Industries Federation, Metal Treating Institute, Special Libraries Assn. and Ultrasonic Manufacturers Assn. The addition of the AWS and AGA to this year's program gives the congress a larger scope than ever before.

All societies except the AIME will hold their technical sessions in Cobo Hall under the same roof with the show exhibits. The AIME will give all but one of its technical sessions at the Pick-Fort Shelby Hotel.

A condensed program guide on p 135 lists the sessions to be held during the week. In addition, two programs will take place during the weekend before the exhibition: an ASM seminar on "Ultra-High Purity Metals," all day Oct 21 and 22; and an AIME technical session which will present papers on the program of the Metallurgy and Ceramics Foundation and the question of establishing a national academy, 8 a.m., Oct 22.

The Exhibits

Over 275 exhibits will be presented at the 43rd National Metal Exposition. A list of the exhibitors begins on p 137. The American Society for Metals, which is sponsoring the show in Detroit's new Cobo Hall, expects over 30,000 visitors.

Materials' properties compared

A Materials Application Center will be the heart of this year's show. This special educational feature will compare seven groups of materials on the basis of seven or more properties in each case. Sample parts, test specimens and graphic material will be used to give comparative information about wrought ferrous, wrought nonferrous, cast ferrous, cast nonferrous, special purpose, nonmetallic and composite materials. The properties that will be treated include: strength, high temperature, corrosion resistance (atmospheric), corrosion resistance (processing), fatigue and low temperature.

Exhibits designed to educate

The show in general will display 11 categories of materials and processes. Allan Ray Putnam, ASM managing director, calls the exposition a "one week, intensive training course for people who must keep abreast of new developments." It is designed to help engineers and executives cut the time lag between the discovery and development of an enormous wealth of technical information and their application of it.

The categories of the show will be: steel; nonferrous metals; nonmetallic materials; nuclear materials; tool materials; cutting off and forming; industrial heating; cleaning and finishing; welding and joining; testing; inspection; control and research; metals production and castings; and parts, forms and shapes for design and application. A twelfth category will be "associations, societies and publishers."

New materials

Several new materials and applications that will be introduced at the show are described starting on p 14.

Hours, Registration and Hotels

Exposition hours:

Monday, Oct 23	10 a.m. to 6:00 p.m.
Tuesday, Oct 24	10 a.m. to 9:30 p.m.
Wednesday, Oct 25	10 a.m. to 9:30 p.m.
Thursday, Oct 26	10 a.m. to 6:00 p.m.
Friday, Oct 27	10 a.m. to 5:00 p.m.

Advance show registration may be arranged by writing to: American Society for Metals, Metals Park, Ohio. No fee is required for ASM members. A fee of $2 is required for nonmembers, and covers all five days of the exhibit and ASM technical sessions.

Hotel reservations may be arranged by writing to: Detroit Metal Show Housing Committee, c/o Detroit Convention & Tourist Bureau, 626 Book Bldg., Detroit 26.

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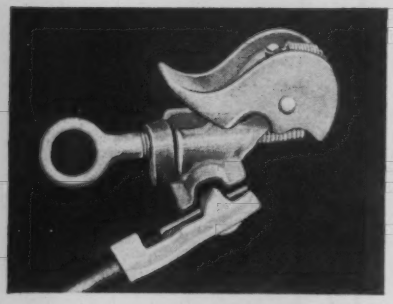
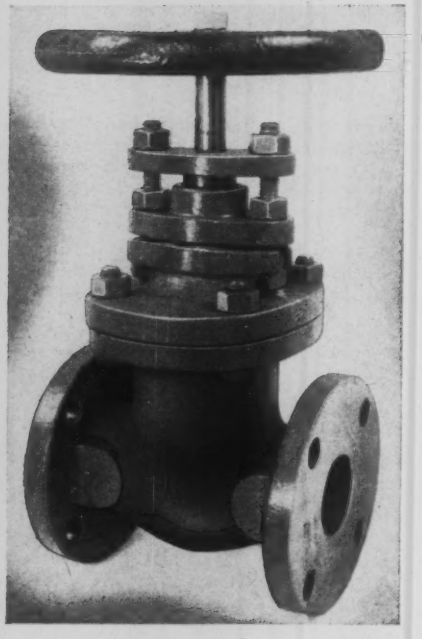


* *Patent Pending*



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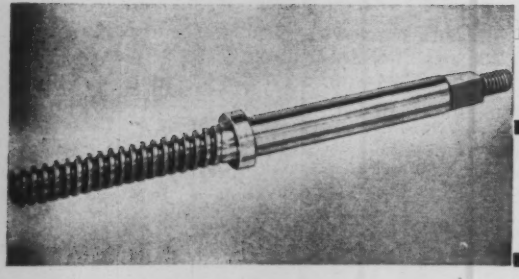

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Condensed Program of Technical Sessions

43rd National Metal Congress

Society →	AMERICAN SOCIETY FOR METALS	SOCIETY FOR NONDESTRUCTIVE TESTING	METALLURGICAL SOCIETY, AIME	OTHER PARTICIPATING SOCIETIES
Mon, Oct 23				
Morning	• Steels (T) • Automotive Corrosion (E)	• Educational Survey	• Coating and Processing Refractories • Work Hardening • Effects of Environment on Strength • High Purity Iron	
Afternoon	• Steels (T) • Automotive Corrosion (E) • Vacuum Techniques in Metallurgy	• Educational Survey	• Processing Refractories • Effects of Environment on Strength • High Purity Iron	
Tues, Oct 24				
Morning	• Carbides in Steels (T) • Cold Forming (E)	• Military Ordnance and NDT	• Continuous Casting • Effects of Environment on Strength • Metallurgy of Refractories	• Industrial Heating Equipment Assn.—galvanizing, heat treating
Afternoon	• Iron-Chromium (T) • Cold Forming (E)	• Mehl Lecture	• Working of Cast Metals • Vacuum Techniques • Metallurgy of Refractories	• American Gas Assn.—heat transfer, convection
Wed, Oct 25				
Morning		• Radiographic Techniques • NDT in Utilities	• Vacuum Techniques • Nuclear Fuel Reprocessing	
Afternoon	• Nuclear Metals (T) • Plastic Deformation (T) • Special Metal Removal (E)	• Electrical and Magnetic NDT • NDT in Utilities	• Nuclear Fuel Reprocessing	• Metal Powder Industries Federation—corrosion, impregnation
Thurs, Oct 26				
Morning	• Physical Metallurgy (T) • Space-Age Metals (T) • Nonmetals (E)	• Transportation and NDT		• American Welding Society—new processes • Metal Treating Inst.—brazing
Afternoon	• Space-Age Metals (T) • Corrosion (T) • Light Metals (E)	• Enrico Fermi Plant		• American Welding Society—gas-shielded processes • Special Libraries Assn.—microstructure and properties • Ultrasonic Mfrs. Assn.—cleaning, machining
Fri, Oct 27				
Morning		• Ultrasonics Research		• Special Libraries Assn.—tour of Ford Motor Co. Scientific Laboratory
Afternoon	• Technical Literature Searching	• Test Applications		• Special Libraries Assn.—tour of Ford Motor Co. Vehicle Test Site

Note: *T* indicates Technical Session, *E* indicates Engineering Session.

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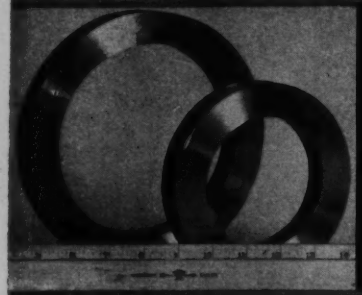

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1961 Metal Show

Exhibitors

Figures indicate booth numbers

Acme Manufacturing Co. 263
Aerobraze Corp. 908
Ajax Electric Co. 452
Ajax Magnethermic Corp. ... 346
Ajem Laboratories, Inc. 1048
Al-Fin Corp. 1011
Aldridge Industrial Oils, Inc. 415
Allegheny Ludlum Steel Corp. 572
Allen Aircraft Products..... 457
Alloy Metal Abrasive Co. 1151
Alloy Products Corp. 935
Alloy Surfaces Co., Inc. 808
Alnor Instrument Co. Div. of Illinois Testing Laboratories, Inc. 915
Alpha Electric Refrigeration Co. 259
Aluminum Co. of America.... 528
American Cast Iron Pipe Co. 1230
American Chain & Cable Co., Inc. 952
American Cystoscope Makers, Inc. 1112
American Gas Furnace Co. .. 821
American Machine & Foundry Co. 711
American Machine & Metals, Inc. 829
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American Pullmax Co., Inc. .. 349
Arcweld Sales Co. 356
American Society for Metals; ASM Information Searching Service; ASM Technical Books Div. 650
Artco, Inc. 160
Ashland Oil & Refining Co. ... 513
Ashworth Bros., Inc. 463
Assembly Products, Inc. 1008
Audubon Metalwave Belt Div., Manganese Steel Forge Co. 633
Automation 328
Autosonics, Inc. 409
Avon Tube Div., Higbie Mfg. Co. 834

Babcock & Wilcox Co., Tubular Products Div. 462
Baird-Atomic, Inc. 253
Balcrank, Inc. 225
Barber Colman Co. 1134
Bausch & Lomb, Inc. 232
Beaver Pipe Tools, Inc. 906
Beryllium Corp. 963
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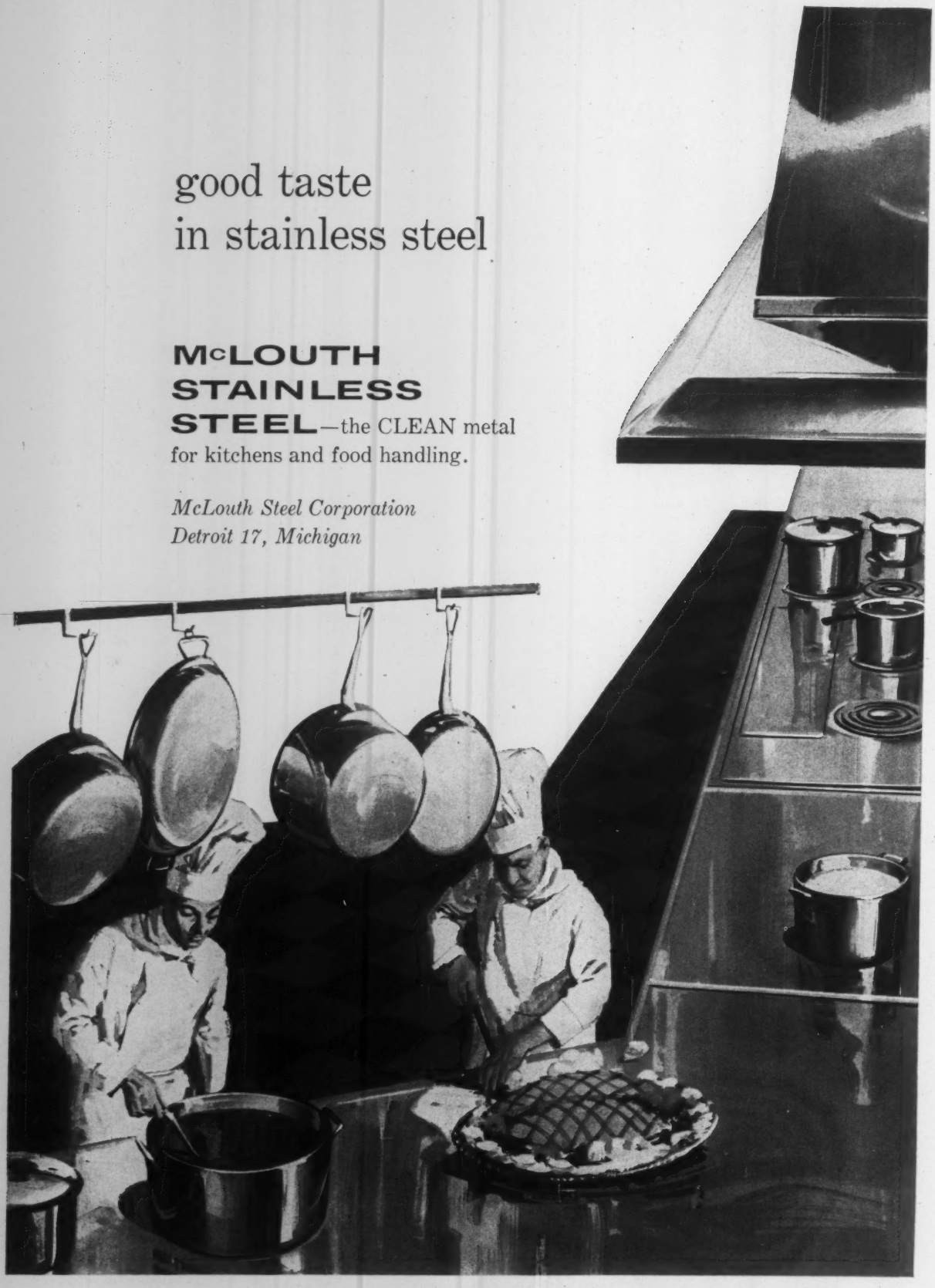
Detroit 17, Michigan



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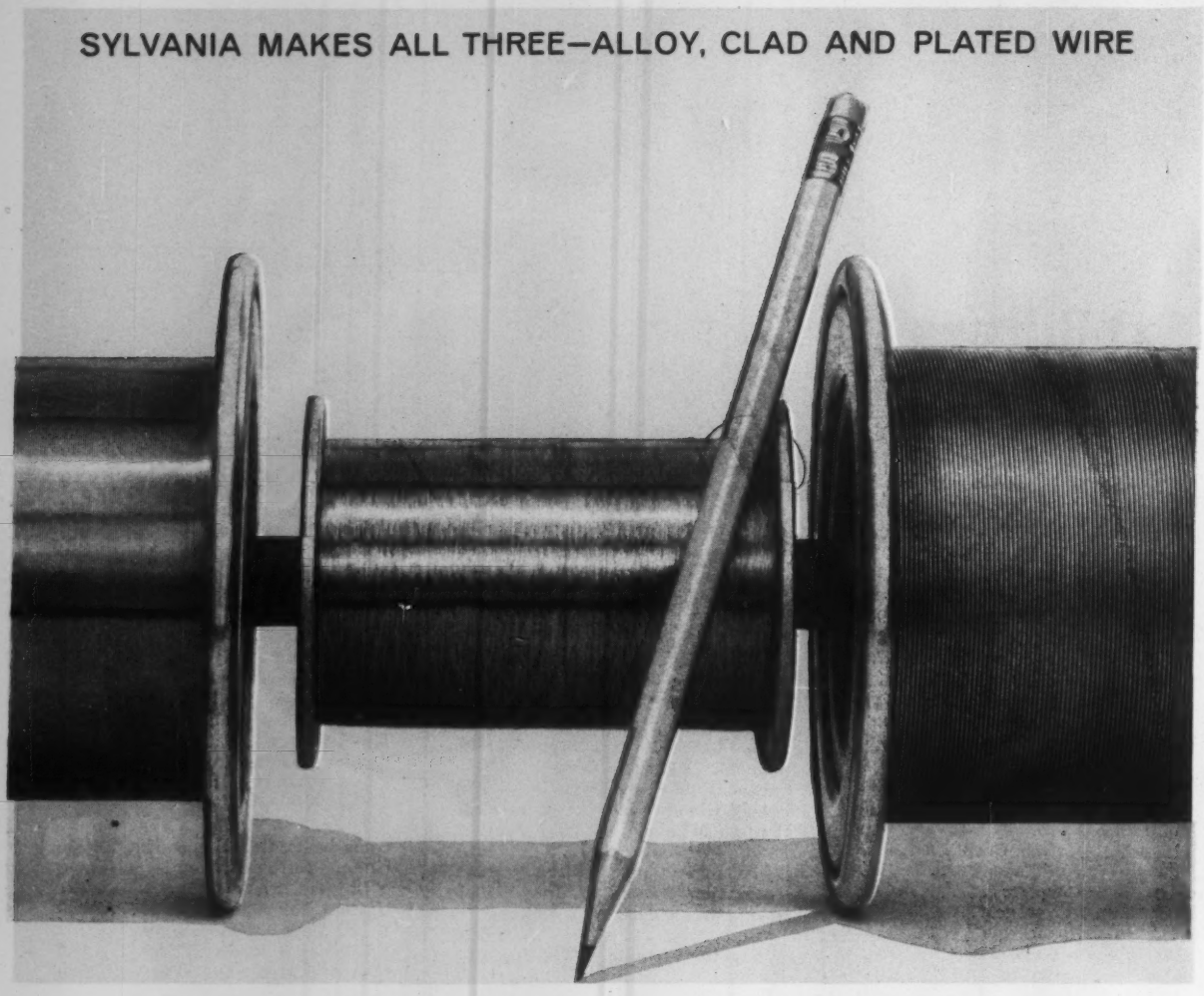

Where to start when you're writing specs

—Let Sylvania give you an unbiased recommendation on wire

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That's why more and more engineers *start* with Sylvania when they specify wire. Of all major manufacturers, only Sylvania makes all three types of bare wire – alloy, clad and plated. Sylvania makes them in a full range of sizes, too—.002″ to .250″. Each and every one retains optimum characteristics up to recommended operating temperatures.

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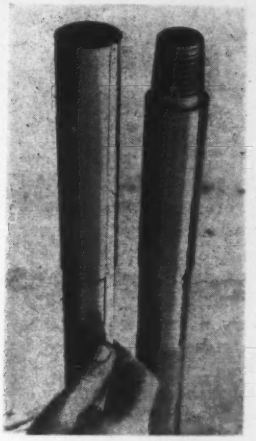
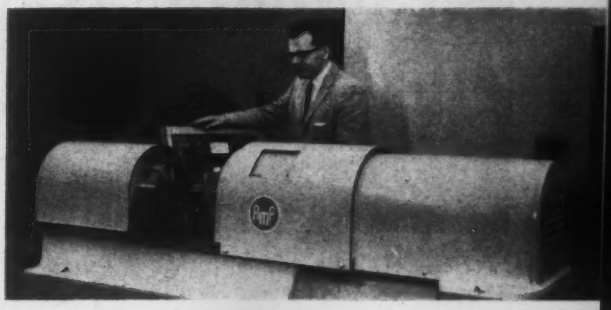


***Tool joints** shown here were welded to 30-ft lengths of tubing by a . . .*



***. . . friction welder.** This prototype machine uses light pressures and high speeds to produce welds in a wide variety of materials.*

First commercial use in this country:

Metal Tubing Joined by Friction Welding

■ Friction welded metal tubing has been made on a production basis for the first time. The welds were made on a prototype machine at the Oklahoma City plant of American Iron & Machine Works Co., Inc., a subsidiary of American Machine & Foundry Co.

A production unit, called Model 15-4 and costing $25 000, is currently available from the Commercial Development Dept. of AMF's Mechanics Research Div., 7501 Natchez Ave., Niles, Ill.

Competes with threaded joints

Cost data compiled during the production run indicate that the new friction welded joint is competitive with threaded and coupled joints and with pressure welded joints.

The machine averaged 20 welds per hr, with runs of 27 per hr occurring frequently. According to AMF, this is comparable in speed to flash welding and is faster than pressure welding and other methods.

Studies by the company's Research and Development Div. shows that friction welding is more efficient than conventional methods and requires less power for many types of welds. The technique also eliminates the need for fluxes and special atmospheres in most applications.

Bonds made with heat

Friction welding, described in the Jan '60 issue of this magazine (p 119), uses heat to obtain bonding action. The mechanical energy of two objects revolving in contact with one another is converted into thermal energy.

In practical terms, the AMF technique consists of holding one object stationary while the other is rotated and pressed against the first. After a specified period of time, rotation is stopped and pressure is increased and held for another specified period of time. The weld is then cooled in air.

Booth No. 711
M/DE KEY NO. 606

Three New Refractory Metal Developments

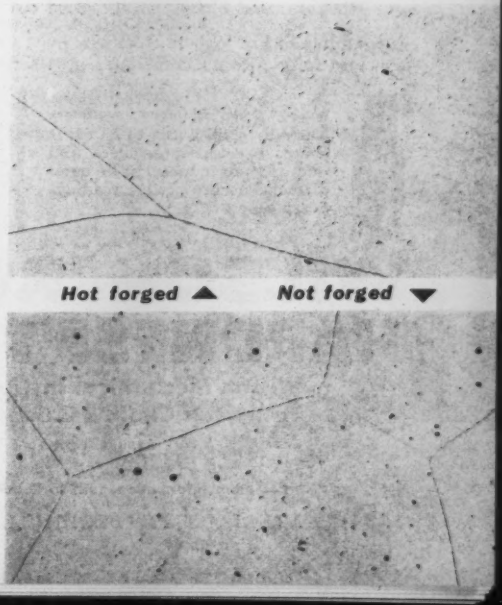
■ Three significant developments in refractory metal technology have been announced by the Materials Mfg. Dept. of Westinghouse Electric Corp., P. O. Box 128, Blairsville, Pa.

The three developments: 1) thoriated tungsten rocket nozzles; 2) stronger molybdenum parts; and 3) a new technique for grain refining refractory metals.

Tungsten nozzles: Recent test firings of new 2% thoriated tungsten rocket nozzles show that they stand up better than commercially pure arc-cast and forged tungsten nozzles. After firing, the thoriated tungsten nozzles showed no deterioration or thermal shock cracking. The nozzles are made by new high temperature sintering and forging techniques (not disclosed).

Molybdenum alloy: Strength of molybdenum alloy TZM (containing 0.5% Ti, 0.15% Zr and 0.03% C) has been improved 30% by forging at temperatures over

Grain Structure of Molybdenum Alloy



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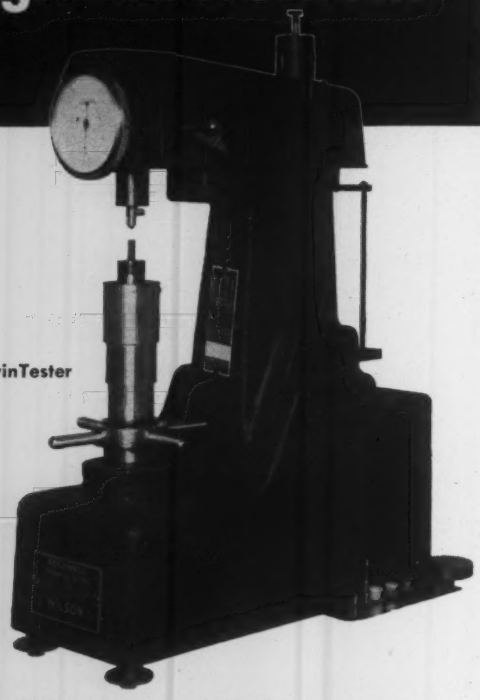


Wilson "Rockwell" TwinTester

• The new Wilson Rockwell TwinTester combines in one instrument the functions of both a Rockwell and a Rockwell superficial hardness tester. Designed primarily for use in such areas as tool departments, maintenance repair shops and laboratories, the TwinTester offers many outstanding features.

Large direct-reading dial is marked with B and C scales for Rockwell hardness, and N and T scales for superficial Rockwell hardness readings. Just one zero set position for all scales.

Easy to operate, the TwinTester can be changed from Rockwell to Rockwell superficial testing in seconds.

Complete equipment includes cowl, ball penetrator for B and T scales, Rockwell test blocks, anvils, dust cover and protective sleeve set.

A complete line of Wilson Rockwell instruments is available, including semi and fully automatic models.

Wilson "Brale" Diamond Penetrators Each diamond is cut to an exact shape. A comparator check and microscopic inspection of each diamond assure perfect readings every time.

Write for details—Ask for Catalog RT-58. It gives complete information on the Superficial tester as well as on the full line of Wilson Rockwell hardness testers.

WILSON "ROCKWELL" HARDNESS TESTERS

ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-E Park Avenue, New York 17, New York

For more information, turn to Reader Service card, circle No. 369

WHAT'S NEW

AT THE SHOW

its recrystallization temperature. An inert atmosphere induction furnace and a commercial forge hammer were used in the operation. Westinghouse says that property improvements are probably due to finer and more uniformly distributed carbides in the alloy's structure (see accompanying photomicrographs).

Grain refinement: An improvement in the grain structure of molybdenum–0.5% Ti as-cast ingots has been achieved with a new technique, complete details of which have not been revealed. Part of the technique is the use of a specially designed and constructed vacuum arc furnace to melt the alloy. The molten metal is magnetically stirred during its solidification. Result: a finer grain structure, providing better extruding characteristics during breakdown of the ingot. The new technique is expected to be used for other refractory metals.

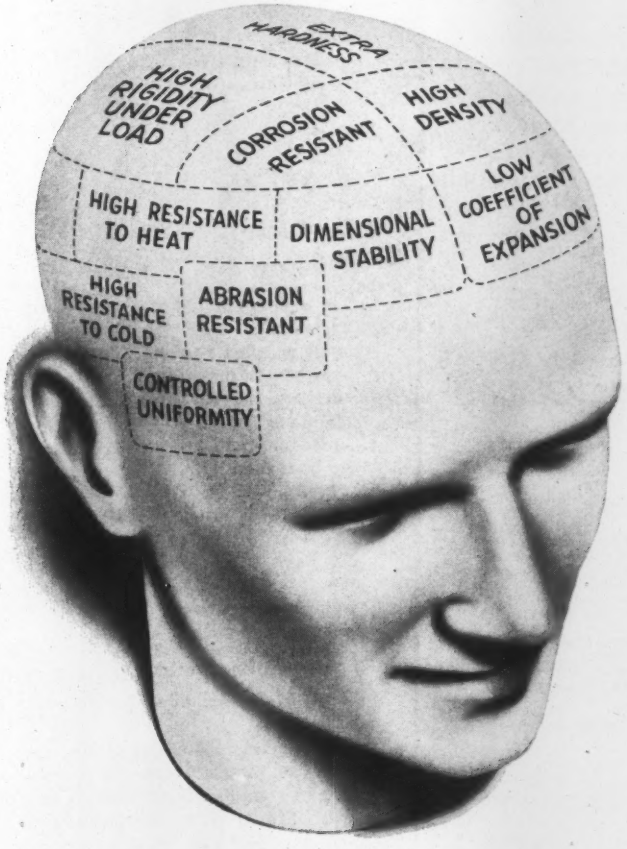
Booth No. 529
M/DE KEY NO. 607

Nickel Electroplates Can Be Less Costly

Lower cost, more uniform nickel electroplates are possible with a new plating concept that uses ball-type anodes in a perforated container made of commercially pure titanium. The process, developed by Univertical Corp., 14841 Meyers Rd., Detroit

***Titanium container** with ball type anodes is used in a new nickel plating method.*

"Whatever the mind of man can conceive and believe, the mind of man can achieve..."



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WHAT'S NEW

AT THE SHOW

27, is said to have the following advantages:

1. The nickel ball-type anodes dissolve completely, compared to conventional nickel anodes which usually have to be replaced after 10 to 40% of their original weight has dissolved. The anodes are easily replenished as they feed downward in the container.

2. The titanium container minimizes iron and copper contamination in the bath; it passes electrical current to metal that is in contact with the nickel ball anodes but does not pass current to the bath solution.

3. General maintenance of anodes and solutions is greatly reduced in the new process, permitting longer plating periods than with conventional methods.

The titanium container sells for $5 per ft; the nickel ball type anodes sell for $1.15 per lb in quantities less than 500 lb and $1.01 per lb in quantities over 60,000 lb.

Booth No. 1225
M/DE KEY NO. 608

Surfacing Method Uses Plasma Arc Torch

A new surfacing technique uses a plasma arc torch to deposit any metal or alloy that can be powdered and that is metallurgically compatible with the base metal (the melting point of the deposit must be comparable to or lower than that of the base metal).

Equipment for the weld surfacing technique is available from Linde Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17. Until now, the plasma arc surfacing technique has been used only in experimental work.

Sprays 6 lb of metal per hr

Advantages claimed for the technique:

1. Penetration of the overlay into the base material can be precisely held to a minimum of 0.005 in.

2. Dilution of the overlay with the base material can be precisely controlled from 5 to 50%.

3. Overlays ranging from 0.010 to 3/16 in. thick can be produced in one pass.

4. More than 6 lb of metal can be deposited per hr at 95% efficiency.

(cont'd on p 146)

Flexibility Unlimited for Epoxy Compounds with these Flexibilizers from Thiokol

THIOKOL® epoxy resin modifiers provide unusual flexibility for formulating flexibilized epoxy base compounds for application in coatings...adhesives...casting...encapsulating...floor surfacing.

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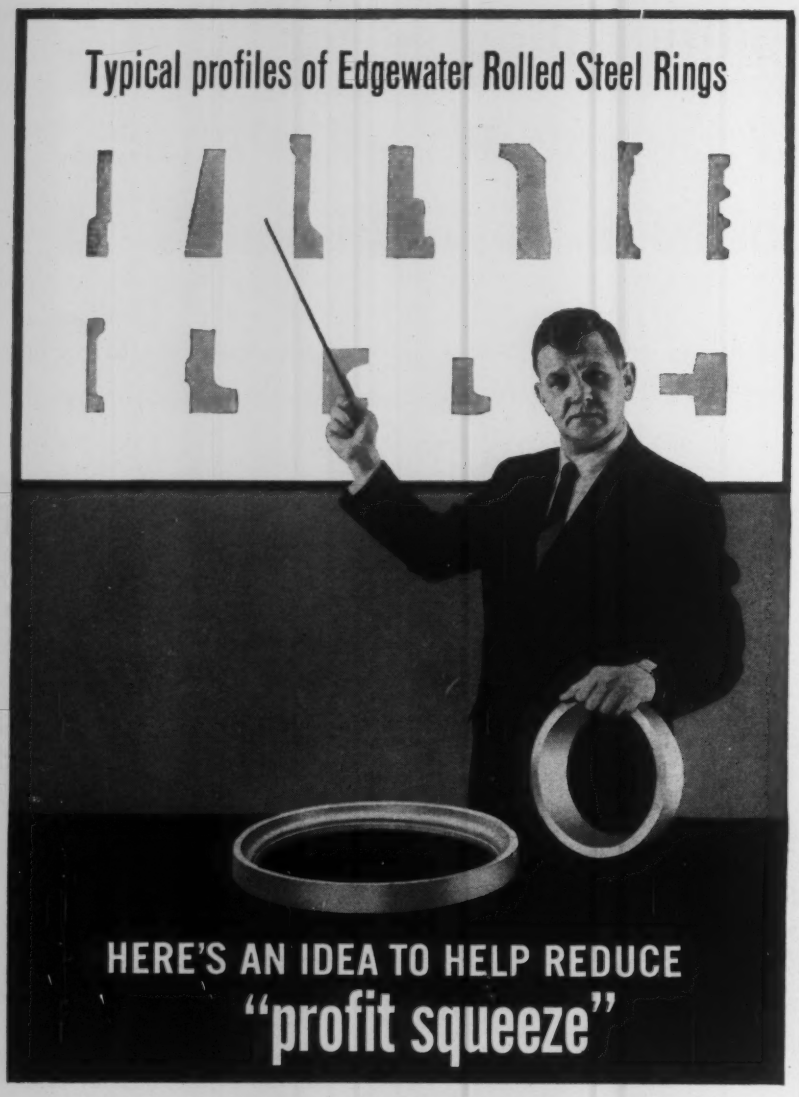


Buy rings that are formed so close to finished shape and dimensions that very little machining will be needed. The result—less labor, less scrap loss, lower overall cost.

Edgewater rings are forged from solid blocks of steel, and rolled by a powerful ring-rolling mill to required cross-section shapes (see typical profiles above). Close tolerances minimize finishing operations.

Edgewater rolled steel rings are of uniform quality, strong and tough. Diameters: from 5 to 145 inches. Send drawings for recommendations and prices.

INTERESTING description of the ring-rolling process is given in this brochure, **Edgewater Rolled Steel Rings.** We will be glad to send you a copy.

EDGEWATER STEEL COMPANY
P. O. Box 478 Dept. MDE, Pittsburgh 30, Pa.

For more information, turn to Reader Service card, circle No. 392

WHAT'S NEW

AT THE SHOW

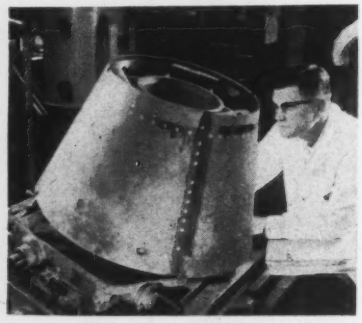
5. A bead as narrow as ⅛ in. or as wide as 1 in. can be made.

6. Deposits require less finishing than those produced by other fusion techniques.

Heats up to 30,000 F

The plasma arc torch, described in the Mar '59 (p 133) and Jan '60 (p 114) issues of this magazine, uses an electric arc column which is forced to operate within a small-diameter tube. Part of the arc and a flow of inert gas pass through the tube. Because of the high temperature of the arc (up to 30,000 F), material passing through it is converted into a fluid. The fluid material is carried out of the torch at speeds up to 10,000 mph.

Booth No. 127
M/DE KEY NO. 609



Beryllium sheet for aircraft— Increased use of beryllium sheet as sheathing and as a structural material for aircraft, missiles and satellites is expected to result from an Air Force-sponsored development program now underway at Brush Beryllium Co., 4301 Perkins Ave., Cleveland 3. The photo shows company engineers inspecting an experimental missile structure made of the sheet.

The program calls for the development of techniques to improve the ductility of beryllium sheet and to obtain better control of flatness and gage. The company expects to be producing standard aircraft size and quality sheet by late next year.

Booth No. 835

Paint for 2500 F

A new high temperature paint called Pyromark has been introduced by Tempil Corp., 132 W. 22nd St.,

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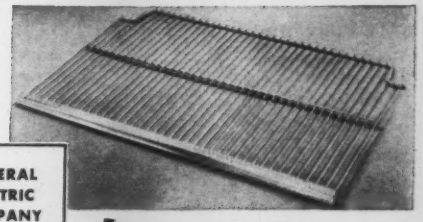
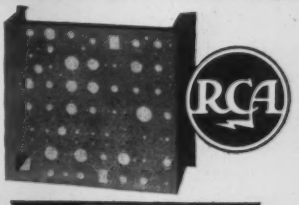
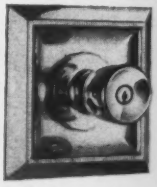
Iridite, in combination with other Allied Research processes, can provide a wide variety of finishes. As an example, Iridite 8-P applied to zinc or cadmium, followed by an application of Irilac, gives a highly attractive simulated brass finish.

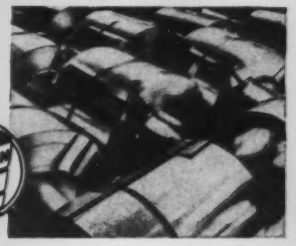


GENERAL ELECTRIC COMPANY





Medalist
NATIONAL LOCK COMPANY



IRIDITE—a specialized line of chromate conversion coatings for nonferrous metals. Easily applied at room temperatures with short immersion times, manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel. Special equipment, exhaust systems or highly trained personnel not required.

For complete information on Iridite, contact your Allied Field Engineer. He's listed in the yellow pages under "Plating Supplies." Or, write for FREE TECHNICAL DATA FILES.

Allied Research Products, Inc.

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BRANCH PLANT: 400 MIDLAND AVENUE • DETROIT 3, MICHIGAN

West Coast Licensee for Process Chemicals: L. H. Butcher Co. • European Agent: Sture Granberger, Storgatan 10, Stockholm, Sweden

Chemical and Electrochemical Processes, Anodes, Rectifiers, Equipment and Supplies for Metal Finishing

IRIDITE® Chromates | IRILAC® Coatings | ISOBRITE® Brighteners | ARP® Supplies | WAGNER Equipment

For more information, turn to Reader Service card, circle No. 337

LET MUELLER MAKE IT!

Mueller Brass Co. of Port Huron is much more diversified than the name "Brass" implies . . . a lot more. In fact, because of its many and varied facilities . . . its *men, methods* and *metals* . . . Mueller is in the unique position of being able to offer true single source service.

MUELLER HAS THE MEN . . . experienced engineers with the ability to work out, creatively, tough design problems, and improve a part or components for production by the most economical method. You get sound engineering plus 44 years of practical metalworking production experience when you "Let Mueller Make It."

MUELLER HAS THE METHODS . . . when you "Let Mueller Make It", you are utilizing one single source that is able to produce parts any one of these ways: as forgings, impact extrusions, sintered metal parts, screw machine products, formed tube or as castings.

MUELLER HAS THE METALS . . . and the materials . . . to produce precision parts in aluminum, brass, bronze, copper, iron, and steel in hundreds of different alloys to meet each exact requirement.

In addition, Mueller Brass Co. has complete and modern facilities for performing all types of finishing and sub-assembly operations. Another plus value is nation-wide sales engineering service.

So, in the final analysis, no matter where you fit in the American industrial picture, whether you're making missiles or mowers . . . and no matter where you're located, it will pay you to LET MUELLER MAKE IT!

MUELLER BRASS CO.
PORT HURON 21, MICHIGAN

For more information, circle No. 354

WHAT'S NEW
AT THE SHOW

New York 11. The paint, a 100% silicone resin-base material, is cured slowly up to 1000 F to convert the organic material into an inorganic silica-type coating.

The cured coating has excellent thermal shock resistance and withstands temperatures up to 2500 F; in some cases it can be used at temperatures over 2500 F. Tests show the paint has excellent adhesion at elevated temperatures.

The paint can be applied by brushing or spraying and dries quickly to a firm coating with good adhering qualities. The developer says adhesion is greatly improved if the surface to be coated is first sandblasted. This is especially recommended in applications where considerable vibration, high velocity gas streams or high angular velocities are encountered.

The paint is available in black and a number of colors at $40 per gal. The black paint is characterized by a high emissivity coefficient (0.85+).

Booth No. 928
M/DE KEY NO. 610

Polycarbonate safety hats—These two gentlemen are modeling a new line of safety hats introduced by Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 44. The new line marks the first time that polycarbonate resin has been used in safety helmets. Tests show that impact and puncture resistance of the hats exceed the requirements set by federal specifications for safety helmets currently on the market. The electric utility hat shown at left is said to keep its dielectric strength under severe impact and at temperatures from —100 to 270 F.

Booth No. 811

Use Bostik® 7026
ADHESIVE

A plastic, plywood and aluminum "sandwich", bonded with Bostik 7026, is a new concept in ski design. This is where adhesives have to bond every inch of the surface perfectly, work under severe strain, hold under heat and cold.

There are over 100 standard Bostik Adhesives that can assure top quality bonding wherever products have to satisfy unusual criteria. Let a Bostik representative help you specify the right one.

Send for the new Bostik METHODS . . .
provides up-to-the minute data and information on the newest in adhesives, plus money-saving ideas and applications.

Whatever your adhesive need write: Bostik, BB CHEMICAL CO., Subsidiary of United Shoe Machinery Corporation, 784 Memorial Drive, Cambridge, Mass.

Bostik®
ADHEREABILITY
U91-62

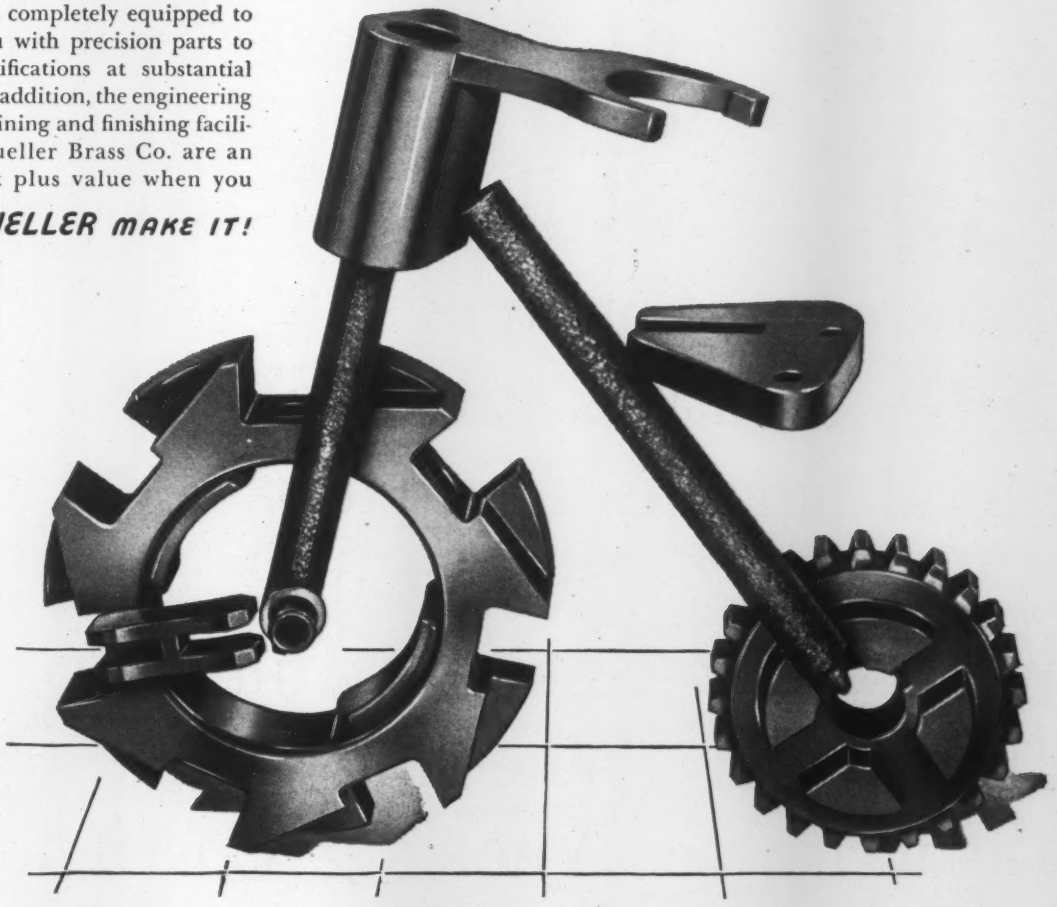
The Skill of Making Things Stick

For more information, circle No. 430

MUELLER CAN MAKE MOST ANYTHING IN SINTERED METAL PRODUCTS...

Sintered metal gears, cams, special purpose filters and structural members from iron, nickel, stainless steel, brass and copper alloys are produced by Mueller for practically every segment of American industry. Whatever your product requirements are, the Mueller Sintered Metal Products Division is completely equipped to supply you with precision parts to exact specifications at substantial savings. In addition, the engineering staff, machining and finishing facilities of Mueller Brass Co. are an important plus value when you

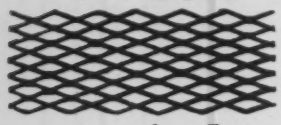
LET MUELLER MAKE IT!

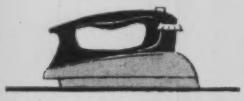
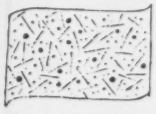
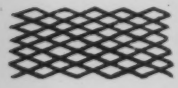
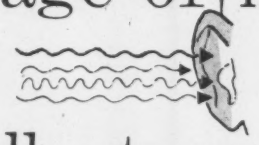


MUELLER BRASS CO.

PORT HURON 21, MICHIGAN

For more information, turn to Reader Service card, circle No. 354

With Wheeling Expanded Metal  , you can reduce product weight .....without sacrificing product strength .

Improve product appearance as well – because Wheeling Expanded Metal comes in flattened  or textured  styles... with large openings or small  . And this practical, decorative metal permits free passage of light , air , sound  and heat . Get the full story..... from your Wheeling man . Or write to Wheeling Corrugating Company , Wheeling, W. Va.

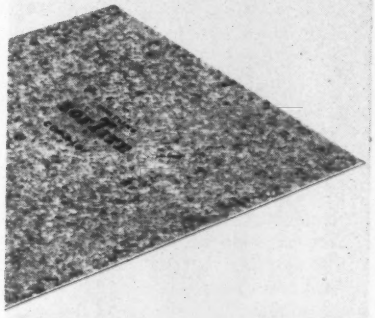
WHEELING CORRUGATING COMPANY • IT'S WHEELING STEEL!

Warehouses: *Boston, Buffalo, Chicago, Columbus, Detroit, Kansas City, Louisville, Martins Ferry, Minneapolis, New York, Philadelphia, Richmond, St. Louis.* Sales Offices: *Atlanta, Houston, New Orleans.*

For more information, turn to Reader Service card, circle No. 356

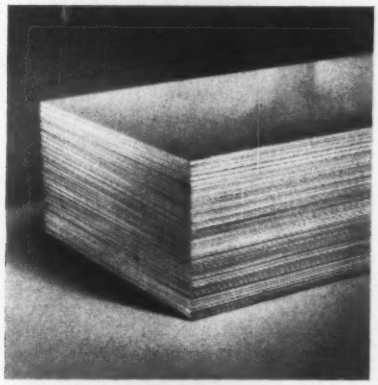
(cont'd from p 17)

OTHER WHEELING PRODUCTS



Wheeling SofTite® Cop-R-Loy® Galvanized Sheets offer outstanding corrosion protection . . . can be painted . . . and formed into any shape specified.

Wheeling Hot and Cold Rolled Sheets are widely known for their smooth, uniform finish. Hot and Cold Rolled Strip also available.



Wheeling Long Terne is available in widths to 48". It is normally supplied with either commercial or special terne coatings.

consistencies it can also be applied by troweling to plaster surfaces and to fill in gaps and cracks. Unlike most fire retardant paints, the coating is not flammable in liquid form.

Protection is provided immediately after application; however, best results are obtained after the coating has been allowed to dry. Drying time varies with the percentage of water used and with ambient temperature. With a water-to-powder ratio of 1:4, drying time is on the order of 1 hr.

If added environmental protection or decorative appeal is needed, the coating can be covered with a colored, rubber-base outdoor or indoor paint.

Typical uses

Because of its special flame and heat resistance properties, the new coating can be used to:

- Fireproof equipment and office cabinets, safes, boxes and partitions.
- Protect missile launching pads and associated equipment. Because the coating can effectively protect instruments, cables and associated equipment, it eliminates the need to replace these items after each firing. An added advantage in such applications is that the coating can be easily washed from surfaces after it has been exposed to heat or flame.
- Prevent heat from weakening metal structures such as beams and columns exposed to high temperatures during fires.
- Protect flammable surfaces in welding operations.

KEY NO. 615

Weldable Stainless Sold as Bars, Castings

Commercial availability of a new type of stainless steel with greatly improved weldability has been announced by Westinghouse Electric Corp., Box 2278, Pittsburgh 30. The steel is called Kromarc 55 and was first introduced last fall (M/DE, Sept '60, p 238).

Sources of supply

Investment and shell mold castings in weights up to 25 lb and limited sizes of plate, sheet, forgings and bars are available from Westinghouse's Materials Mfg. Dept. Welding electrodes of the alloy are sold by the company's West-Ing-Arc Dept. Large sand and Shaw process castings are supplied by Bonney-Floyd Co., Columbus, Ohio under a licensing arrangement with Westinghouse.

The new stainless steel contains 16% chromium, 20% nickel, significant amounts of manganese and molybdenum, and smaller amounts of silicon, carbon and other impurities.

The alloy combines a 100% austenitic structure with high ductility, crack resistant welds and crack-free base metal. The fully austenitic weld deposit eliminates the need for post-weld heat treatment. Westinghouse says Kromarc 55 weld deposits are as resistant to hot cracking as conventional stainless steel deposits with 5 to 10% delta ferrite, but avoid the problems usually associated with delta ferrite.

High, low temperature use

According to the producer, the weldable stainless steel can be used in parts for elevated temperature service. The alloy is particularly suited for use in steam turbines where large sections and large diameter, thin-walled pipe are welded together. In these applications Kromarc 55 alloy can be used in the

more engineers are discovering BRAND NEW USES for low cost

CLEVELITE*

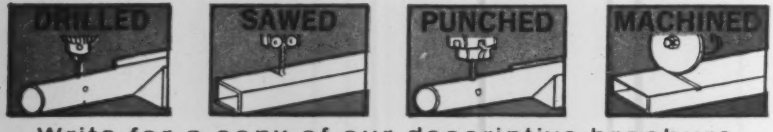
laminated phenolic tubing

Light as aluminum, structurally strong, exceptional chemical properties and high insulation resistance —this tubing is superior to many other materials.

In numerous applications, imaginative engineers are improving their products with Clevelite . . . and at lower cost.

PHYSICAL PROPERTIES	
Inside diameter	.090" to 8.000"
Wall thickness	.0075" to .250"
Length	⅛" to 8½ feet
Heat resistance	250°F. continuous
Specific gravity	0.98—1.10
Acetone extraction	<4%
Colors	Natural & Black

CLEVELITE CAN BE...



Write for a copy of our descriptive brochure.

*Reg. U. S. Pat. Off.

THE CLEVELAND CONTAINER COMPANY

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ABRASIVE DIVISION at CLEVELAND, OHIO

PLANTS & SALES OFFICES: CLEVELAND, CHICAGO, MEMPHIS, DALLAS, LOS ANGELES, PLYMOUTH, WISC., JAMESBURG, N. J., GREENSBORO, N.C.

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NEW ENGLAND: R. S. PETTIGREW & CO. 10 N. MAIN ST., WEST HARTFORD, CONN.

PHILADELPHIA: MIDLANTIC SALES CO. 9 E. ATHENS AVE., ARDMORE, PA.

LOS ANGELES AREA: THE ROBISON CO. 4026 W. 183rd ST., TORRANCE, CALIF.

CANADA: PAISLEY PRODUCTS CO. LTD. 36 UPTON RD., SCARBOROUGH, ONT.

For more information, turn to Reader Service card, circle No. 400

weld rod as well as in the cast or rolled sections being joined. It is also suitable for joining other austenitic stainless steels such as type 316.

The material can also be used where weldability and strength at temperatures up to 1200 F are required and where large sections must be welded such as in petroleum and chemical processing equipment. Thin sections such as those used in vacuum systems can be readily welded by conventional fusion welding techniques.

Another possible application for the alloy is at cryogenic temperatures down to –452 F. Tests indicate that the alloy is completely stable and has good strength properties at these temperatures. **KEY NO. 616**

Noted briefly in our August issue.

Fire Resistant Cloth

A new fire resistant cloth—a combination of highly reflective aluminum foil and asbestos cloth—is designed for use as fire curtains, baffles, reflective blankets, folding doors, partitions and fire entry garments.

Called Kamklad, the material is available from Keasbey & Mattison Co., Ambler, Pa. The cloth is supplied in 40-in. widths.

The cloth is said to have better resistance to heat and abrasion than other fire resistant cloths because the aluminum barrier is 50 times thicker than that used on aluminized cloths produced by vapor deposition methods.

The cloth is also said to retain its shape and strength after direct exposure to fire and water. No glass yarns or filaments are used in the construction. **KEY NO. 617**

Oriented Acrylic Is Tough, Crack Resistant

Commercial availability of a molecularly oriented, clear acrylic sheet has been announced by Rohm & Haas Co., Washington Sq., Philadelphia 5. Introductory price for the sheet, designated Tuffak, is 65¢ per sq ft.

Alignment of the molecules in the

ALUMON® "D"

Plating on aluminum made easy

WITH ALUMON "D" DILUTE ZINCATE

BLISTER-FREE PLATING ON COMPLEX PARTS

Alumon "D" quickly penetrates blind holes, screw threads, grooves, other areas difficult to plate using ordinary zincate baths. Adhesion is excellent; solution rinses freely; and carry-over into plating baths is minimized. Parts shown are plated aluminum components of the U.S. Army Hawk missile weapons system produced by Raytheon's Aero-Weapons Division.

REDUCES DRAGOUT

Alumon "D" thin liquid drains rapidly, reducing solution dragout losses to a minimum. In laboratory tests on identical parts, the amount of solution dragged out of an Alumon "D" bath was less than 1/3 the amount dragged out of a conventional zincate bath. The amount of salts dragged out is less than 1/12 as much.

SHORTENS MAKE-UP TIME

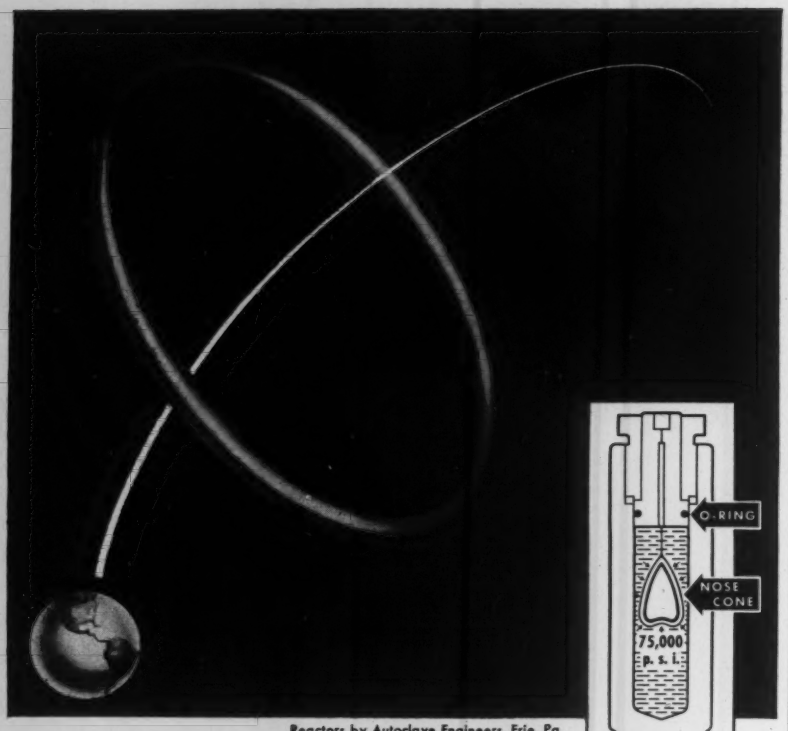
Alumon "D" is easy to make up. One hundred gallons of solution requires addition of only 20 gallons of Alumon "D" Liquid (or 100 lbs. of Alumon "D" Powder) to water, compared with dissolution of 450-500 lbs. of powdered chemicals for a conventional bath. For detailed information, write today to: Enthone Incorporated, 442 Elm Street, New Haven 8, Conn.

ENTHONE

ANOTHER PRODUCT OF *Enthonics* RESEARCH

A Subsidiary of American Smelting and Refining Company ASARCO

For more information turn to Reader Service card, circle No. 432



Reactors by Autoclave Engineers, Erie, Pa.

Continental "O" Rings Help Put Satellites in Orbit

Almost as dramatic as the thrust of a satellite into outer space is the technique used to fabricate the nose cone of the missile. These nose cones, made either of powdered metals or refractory materials, are being compacted in 12" I.D. pressure vessels under hydrostatic pressure of 75,000 P.S.I. *Imagine the problem involved in sealing a vessel against such terrific pressure!*

Yet *THAT* is the problem solved by this Continental "O" Ring. Obviously an ordinary "O" Ring would not do. The job called for a special compound with molecular formation so precise that separation or micro-leakage just could not occur. Continental developed the compound that meets this rigid test. What's more, the elasticity of the rubber refuses permanent set and thus permits re-use of the ring.

This unusual rubber problem typifies the complete engineering service available to you here at Continental. Whether you need molded or extruded rubber parts, consult with us *while your new products are still on the board.* Let us suggest how you might save both tooling and material costs—and get a better product for the job.

Hydrostatic Pressing (see diagram).

A technique for producing uniform compaction and grain structure to obtain super hardness and impact resistance in critical components. A steel forming-mandrel is coated with a refractory material, placed in a rubber bag and suspended in pressure vessel. Pressure is applied until required density is attained.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1985 LIBERTY ST. • ERIE 6 • PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 402

What's new IN MATERIALS

PROPERTIES OF TWO ACRYLIC SHEETS COMPARED*

Type →	Plexiglas G	Tuffak
Specific Gravity	1.19	1.19
Flammability, ipm	2.0	2.0
Heat Dist Temp, F	210	189
Max Svc Temp, F	180-190	170-180
Ten Str, psi	11,800	11,900
Mod of Elast, psi	4.4×10^5	4.6×10^5
Elong, %	5	26
Flex Str, psi	20,000	23,000
Compr Str, psi	18,500	18,500
Hardness (Rockwell)	M87	M88
Dielec Str (short time), v/mil	600	600
Dielec Const (60 cps)	3.6	3.6
Power Factor (60 cps)	0.07	0.07
Dissip Factor (60 cps)	0.23	0.23

*Tests performed on 0.060-in. thick specimens.

plane of the sheet is said to significantly improve its resistance to cracking and crazing. An increase in tensile elongation before rupture is also obtained, along with a reduction in notch sensitivity. Although the sheet is rigid, it is extremely flexible and can be readily cold formed.

Compared to conventional Plexiglas G, the new acrylic sheet can be nailed or punched without cracking if proper techniques are used. Nails should be placed at least ¼ in. from the edge of the sheet; matched metal dies with a clearance of approximately 0.001 in. should be used for punching.

The new sheet is more flexible than Plexiglas in the same thickness. It can be cold formed to a 60t radius compared to 180t for Plexiglas G. Tuffak also has better resistance to crazing under stress and in the presence of solvents.

The clear acrylic sheet is sold in two sizes: 42 by 42 in. and 84 by 84 in. Both sheets are 0.050 in. thick. Colored sheets are expected on the market shortly. **KEY NO. 618**

Electrostatic System Applies All Paints

A new electrostatic paint spray system now available can be used to apply all types of paint including porcelain enamel and water-base paints.

The system, developed by Ionic

WHY PAY FOR METAL WASTE?

Here is how to cut costs on your next tube order... by eliminating excessive metal waste and unnecessary machining time.

NOW FOR THE FIRST TIME you can order the exact size tube O.D.'s you need from 2.25" to 50" with wall thicknesses from .25" to 8". An exclusive "first" in centrifugally spun tubing — the ACIPCO CERAM-SPUN® process* makes this revolutionary development possible.

YOU BUY WHAT YOU NEED... NO MORE. Furthermore, the cost of unwanted crop ends can be eliminated and tubes can be cast to specified lengths from 4 feet to 20 feet. Longer lengths are made by welding.

OTHER ADVANTAGES? ACIPCO's complete "under one roof" operations — including heat treating, machining and welding — save you the delays and excessive costs that often result in buying from multiple supply sources.

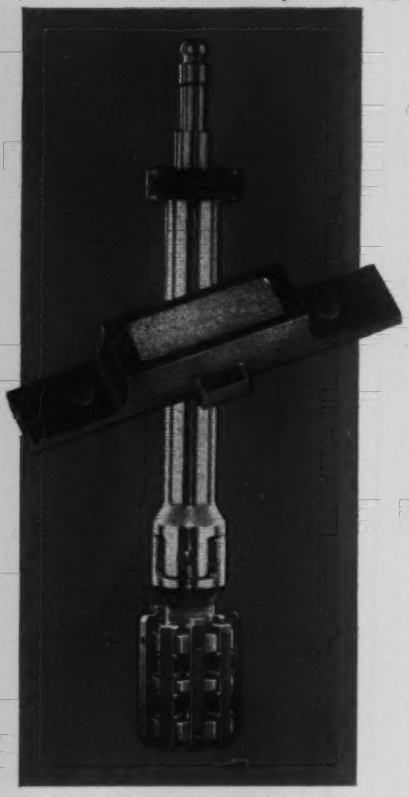
Let us tell you more about ACIPCO CERAM-SPUN® ... contact us today. ACIPCO STEEL PRODUCTS, Division of American Cast Iron Pipe Company, Birmingham 2, Alabama.

*Patent applied for

ACIPCO CERAM-SPUN®
STEEL TUBING

For more information, circle No. 362

If phenolics can do it, **PLENCO** can provide it—and does—for **MICROMATIC HONE CORPORATION**



this is the holder
(MOLDED WITH PHENOLICS)

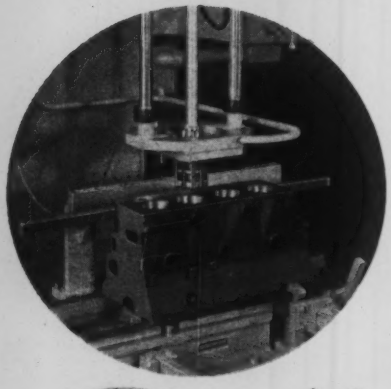
that grips the "stone"
(THE ABRASIVE CUTTING-SURFACE)

that puts the hone
(THE ULTRA-PRECISION TOOL)

in **Micromatic Microhoning**
(THE CONTROLLED ABRADING PROCESS)

One of the most efficient methods devised for the removal of stock from internal and external cylindrical surfaces is the modern *Microhoning* process, developed by Micromatic Hone Corporation, Detroit, Mich. Control is so positive and results so precise that geometric tolerances to within .0001 of an inch are obtainable.

A key to this performance excellence is the abrading surface or "stone"—fitted precisely and gripped securely by its molded holder. When *Plenco* phenolics are specified as the molding material, it is on the basis of the compound's adaptability to a range of abrasive grades, and its uniform flow, *uniform shrinkage*, assured dimensional stability.



Ready-made or custom-formulated, Plenco molding compounds meet the critical demands of industry in countless, varied applications. Please feel free to consult with our staff about *your* molding problem.

PLENCO PHENOLICS FOR BETTER PLASTIC PRODUCTS

MICRO MATIC

PLENCO

PHENOLIC MOLDING COMPOUNDS

PLASTICS ENGINEERING COMPANY

Sheboygan, Wisconsin

Serving the plastics industry in the manufacture of high-grade phenolic molding compounds, industrial resins and coating resins.

For more information, turn to Reader Service card, circle No. 382

What's new IN MATERIALS

Electrostatic Corp., 111 Monroe St., Garfield, N. J., uses centrifugal and air atomization with electrostatic deposition. According to the developer, systems that rely solely on electrostatic atomization, dispersion and deposition techniques are limited in the types and quantities of coating materials that can be applied.

Three models available

No. M-50 is a patented, reciprocating twin-disk accelerated centrifugal type coating system that can be used for either single color or multicolor coating applications.

No. 25 uses variable high speed turbine driven conical atomizers mounted perpendicular to objects to be coated. Atomization is accomplished by accelerated centrifugal force, and deposition by a combination of air, centrifugal force and electrostatic precipitation.

No. 14 uses various types of patented electrostatic spray guns and nozzles. Compressed air is used for atomization and dispersion of coating materials. **KEY NO. 619**

Heat Reflective Tapes Protect Wires, Motors

Two new tapes are designed to reflect extreme heat from motors, wires and missile parts. Both tapes are laminations of thin aluminum foil to glass cloth that has been coated with a silicone adhesive.

PD-455 is the name given to a heat reflective tape available from Mystik Adhesive Products, Inc., 2635 N. Kildare Ave., Chicago 39. The company says its tape has been developed to meet the need for a highly efficient heat shield to protect missile parts from intense radiant heat during blast-off; the tape is also useful as a heat shield for wire hardnesses and other vital hardware during flight.

In a recent demonstration, a tumbler filled with ice cubes was wrapped with the tape and subjected to intense heat from a propane torch. The interior of the tumbler remained cool and the ice cubes did not melt (see accompanying photo on p 158). **KEY NO. 620**

No. Y-9050 is the name of a new

THE RESEARCH STORY BEHIND THIS AD

ZINC

—Chosen By Process Of Elimination

Which car is more rust resistant?
ours
14 others
Special zinc coating protects body parts against corrosion in the 1961 Ford Family of Fine Cars
Ford Motor Company builds better bodies
FORD · FALCON · THUNDERBIRD · COMET · MERCURY · LINCOLN CONTINENTAL

FORD TESTED

A — ORGANIC COATINGS
1. Primers (Solvent Base and Water Emulsion Base)
2. Metallic Rich Paints
3. Plastic Coatings
4. Self Foaming Materials
5. Greases, Waxes, etc.

B — STEEL ALLOYS
1. Stainless Steel
2. Special Alloys

C — MORE UNUSUAL METHODS
(Such as vapor phase inhibitors, irradiated steels, forced ventilation, etc.)

D — METALLIC COATINGS
1. Aluminum Clad
2. Terne Plate
3. Tin Plate
4. Cadmium Plate
5. Zinc Coated
   A. Electrogalvanized
   B. Hot Dipped

Reprints of an extensive report on the Ford research program which culminated in their choice of Zinc are available on request from St. Joe.

The search for the best defense against corrosion was a major project with Ford Motor Company. A long and painstaking series of laboratory, road and production tests were scientifically conducted and evaluated before Ford named the winner—*galvanized steel.*

FORD EVALUATED THEM FOR

1. Corrosion Protection
2. Formability
3. Weldability
4. Painting
5. Method Employed (special requirements in applying, inspection, etc.)
6. Stock (and scrap) handling problems, if any
7. Cost

Corrosion-Protection Is A Job For ZINC

—AND THE ZINC FOR THE JOB

ST. JOSEPH LEAD COMPANY ST. JOE

250 PARK AVENUE NEW YORK 17, N.Y.

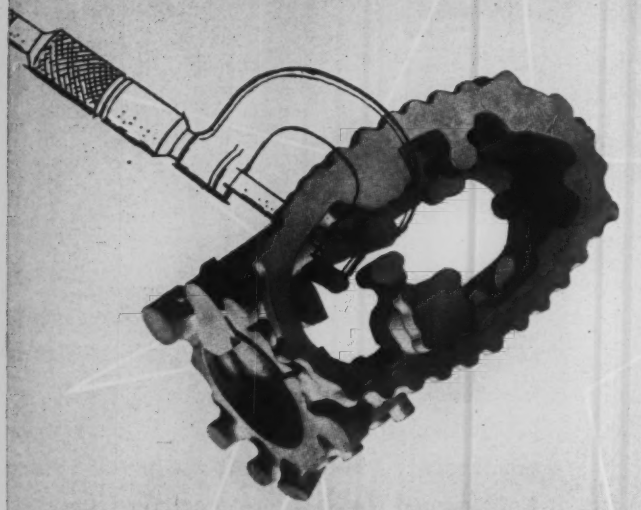
ZN-192

For more information, turn to Reader Service card, circle No. 322

• tolerances
• soundness
• intricacy

"Believed Impossible"

WAUKE-SHA CASTINGS



Before now . . . it was thought impossible to cast alloys to dimensional tolerances of ±.005, without expensive machining.

Exclusive Wauke-Sha ceramic molds prevent voids, even with light and heavy adjacent sections, reproduce hairline intricacies without porosity or surface blemish. Only this patented Wauke-Sha process assures:

- intricate parts with no costly machining
- hairline reproduction of detail
- no cracking or tearing
- no porosity, internal voids, cracks
- no surface gas holes, blemishes, inclusions

Wauke-Sha castings make possible full design flexibility without limitation on casting size. Every day . . . Wauke-Sha castings are meeting the severe conditions in the nuclear field, where "soundness" is imperative.

Waukesha Foundry Company

WAUKESHA FOUNDRY CO.
Dept. F Waukesha, Wis.
Manufacturers of corrosion-resistant castings, inclusive of non-galling alloys, Stainless Steel, Waukesha Metal, Monel, Pure Nickel, Inconel, Ni-Resist, plus special Nickel-Chromium Alloys for specific applications.

For more information, turn to Reader Service card, circle No. 366

What's new IN MATERIALS

Reflecting *radiant heat from a propane torch, Mystik's new tape keeps ice cubes in tumbler from melting.*

heat reflective tape introduced recently by Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. The tape is capable of performing continuously at temperatures up to 600 F, and can withstand more than 3000 F of radiant heat for short periods of time. Easy to handle, the tape readily conforms to irregular shapes and curved pipes. It weighs 0.0038 lb per ft per in. of width, and has a tensile strength of 75 lb per in. of width. It is sold in widths from ¼ to 36 in., and in roll lengths of 36 yd. KEY NO. 621

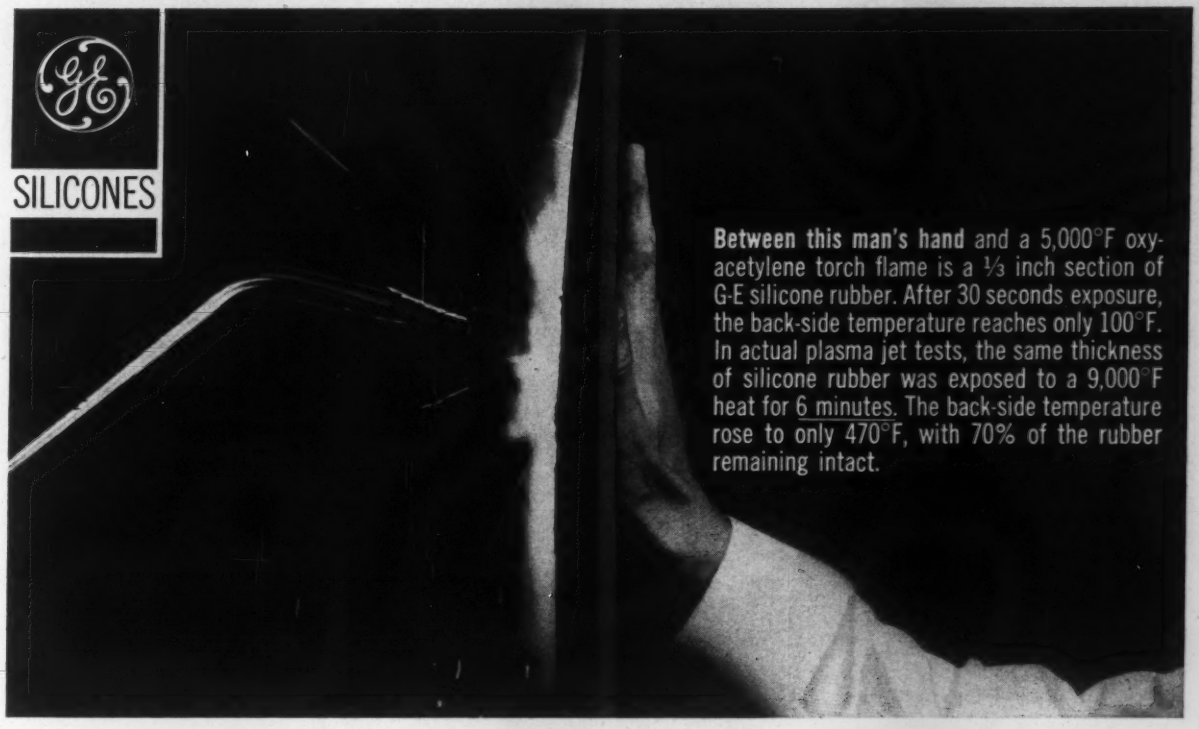
Steel for Mufflers, Anti-Smog Devices

A new type of stainless steel has been developed especially for use in mufflers and anti-smog devices. Called MF–1, the steel has been introduced by Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22.

Although composition of the steel has not been completely disclosed, the company says it has "a chromium content of 11% with titanium and other elements added. . . ." The steel is said to be corrosion resistant, unusually ductile and very easy to weld.

Allegheny Ludlum metallurgists estimate that MF–1 stainless steel is five to six times more corrosion resistant than aluminized steel and 15 to 18 times more corrosion re-

SILICONES



Between this man's hand and a 5,000°F oxy-acetylene torch flame is a ⅓ inch section of G-E silicone rubber. After 30 seconds exposure, the back-side temperature reaches only 100°F. In actual plasma jet tests, the same thickness of silicone rubber was exposed to a 9,000°F heat for 6 minutes. The back-side temperature rose to only 470°F, with 70% of the rubber remaining intact.

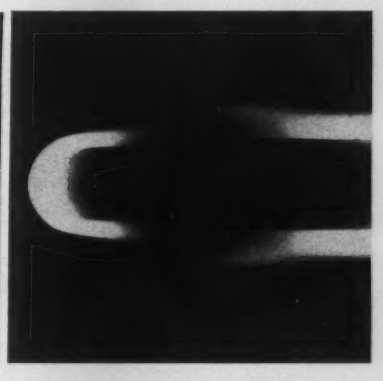
Thermal barrier against 5000°F flame

GENERAL ELECTRIC SILICONE RUBBER

RESULTS OF PLASMA JET TESTS AT 9,000°F

Flight Simulation
Vel.=17,000 ft./sec.
Alt.=250,000 ft.

Exposure time at 9,000°F	Back-side temperature of ⅓ inch section of G-E silicone rubber
30 seconds	100°F
2 minutes	210°F
3 minutes	300°F
4 minutes	375°F
5 minutes	430°F
6 minutes	470°F



The surface of the tested rubber section forms a hard, carbonaceous crust, while the underside remains flexible and undamaged. Preliminary tests showed the effective heat of ablation to be eight times better than presently used plastics, with one-seventh the rate of ablation and one-fourth the weight loss. Here is an excellent ablative covering with low thermal conductivity.

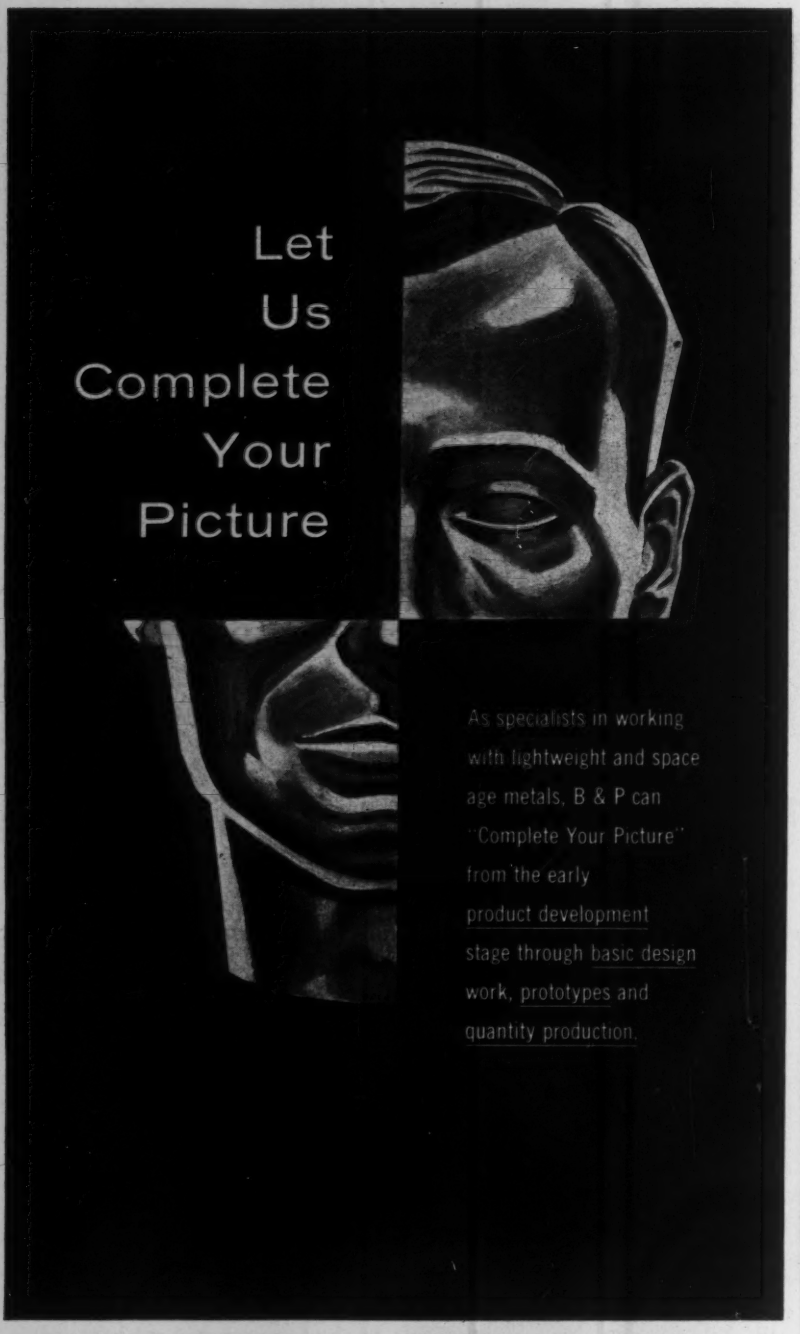
The above chart shows how the high thermal insulation of G-E silicone rubber is maintained during exposure to 9,000°F heat. It is also useful in mechanical and electrical applications at temperatures from —150°F to 600°F, where it remains resilient and flexible. It also maintains its excellent physical and electrical properties over this wide temperature range for extended periods.

Continued high temperature testing goes on at General Electric's Missile and Space Vehicle Department in Philadelphia. Shown above is a typical specimen undergoing plasma jet testing in an electric arc heated supersonic wind tunnel. Continuous testing like this will develop new data on the thermal and ablative uses of G-E silicone rubber.

To learn more about G-E silicone rubber, and its uses as a thermal and ablative material, write: General Electric Company, Silicone Products Dept., Section B1061, Waterford, New York.

GENERAL ELECTRIC

For more information, turn to Reader Service card, circle No. 403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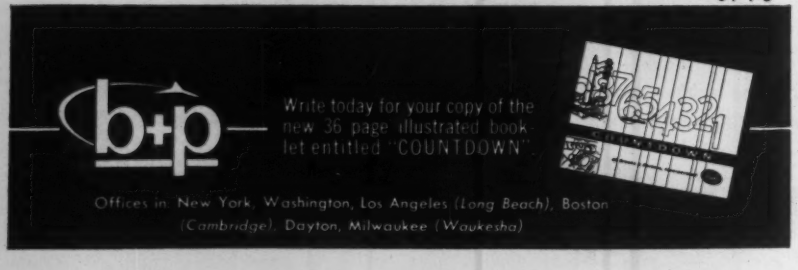
b+p
Write today for your copy of the new 36 page illustrated booklet entitled "COUNTDOWN".
Offices in New York, Washington, Los Angeles (Long Beach), Boston (Cambridge), Dayton, Milwaukee (Waukesha)

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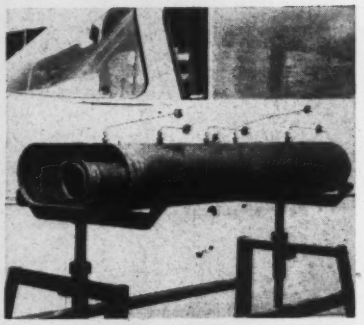

Anti-smog device *now undergoing extensive road tests is made of Allegheny Ludlum's new MF–1 stainless steel.*

sistant than conventional mild steel now being used in most of today's mufflers.

The new steel is presently being used in mufflers on the 1961 Thunderbird. And Arvin Industries, Inc., Columbus, Ind. reports it is making replacement mufflers of MF–1 steel in 16 different sizes to fit most American-made cars going back to 1949.

Allegheny Ludlum says that its new steel is currently being road tested for use in both catalytic and direct flame afterburner anti-smog devices. In some of the tests the stainless steel parts make up virtually the entire device; in others only the most corrosive parts are made of the stainless steel. **KEY NO. 622**

Vinyl Plastisols for Wire, Cable Insulations

Four new or improved vinyl plastisol resins have been introduced recently by Monsanto Chemical Co., Plastics Div., Springfield, Mass. The resins are said to be particularly suited for insulating wire and cable and for flooring. Sold under the tradename Opalon, the resins have good physical and electrical properties.

No. 440 is a fine white powdered plastisol resin that has good clarity, moisture resistance, heat stability and flow propertes. It has a specific viscosity of 0.55 to 0.57.

No. 660 is a high molecular weight,

Heat resistance plus high hot-strength are critical requirements in these heavily-loaded trays and fixtures, carrying truck gears through a carburizing system. Trays and fixtures are Type HT* high-nickel alloy castings. This alloy is one of five whose high-nickel content—over 25%—gives them unequalled resistance to elevated temperatures and carburizing atmospheres.

High-nickel alloy castings help solve the problem of thermal fatigue

What's your problem with thermal fatigue? You can probably solve it, economically, by selecting from today's high-nickel casting alloys. Their strength and ductility combined with a relatively low coefficient of thermal expansion result in high resistance to repeated thermal shocks. They're delivering impressive service in heat treating, chemical processing and many other demanding applications.

In this versatile family of austenitic nickel-chromium-iron alloys, you'll find useful strength and long life at temperatures from 1200 to 2300°F.

You'll find remarkable combinations of high tensile strengths, stress-to-rupture values, creep resistance. You'll find properties to withstand many oxidizing and reducing environments, carburizing and nitriding atmospheres.

Special resistance to scaling, to thermal shock, stress-corrosion cracking or sigma phase embrittlement are among other useful properties offered by alloys in this group.

And there's valuable design information—plus full data on these alloys—in the new 64-page booklet, "Heat Resistant Castings, Corrosion Resistant Castings . . . Their Engineering Properties and Applications." A copy is yours for the asking.

*Alloy Casting Institute designation

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

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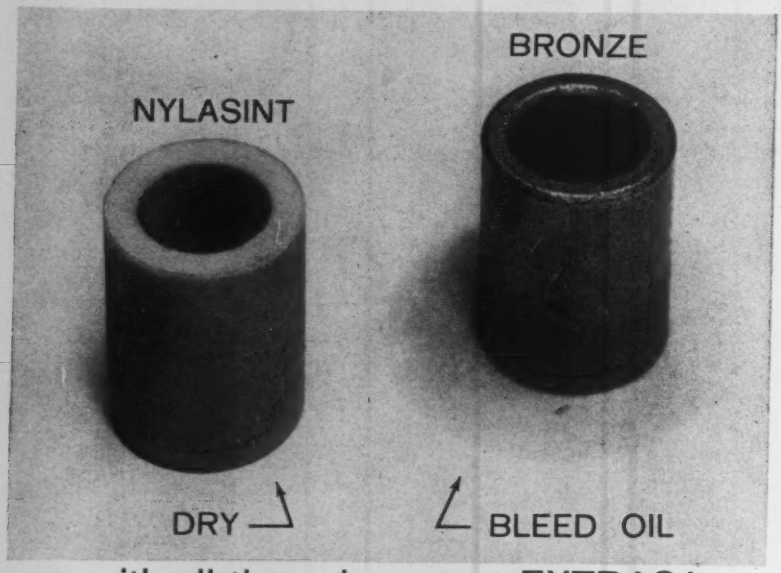
Only **NYLASINT®** nylon gives you **permanent built-in lubrication**



with all these important EXTRAS!

- Higher heat distortion temperature
- Lower deformation under load
- Lower hygroscopic and thermal expansion
- Improved wear and abrasion resistance
- Longer life, trouble free service

Unlike oil-impregnated, sintered bronze which bleeds readily on paper (see above), NYLASINT sintered nylon parts hold up to twice as much oil, are permanently lubricated to reduce friction, increase wear resistance and eliminate contact corrosion.

Inorganic additives also give resilient NYLASINT parts outstanding dimensional stability and high load capacity . . . important for such diverse fields as missile components and steel office furniture.

With NYLASINT you get all the prime advantages of nylon plus extra performance no other material offers in applications such as bearings, bushings, rollers and gears.

For complete technical data on NYLASINT, call or write for new NYLASINT Bulletin BR-1111.

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Halex Corporation (A Subsidiary)
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STOCK SHAPES • SINTERED PARTS • MOLDING RESINS • WHIRLCLAD® COATING

For more information, turn to Reader Service card, circle No. 359

fast mixing resin designed especially for wire and cable extrusion compounds. Specific viscosity: 0.55.

No. 650 is similar to Opalon 660, but has a lower molecular weight. Specific viscosity: 0.48.

No. 630 is a low molecular weight resin that is especially suited for solid vinyl floor formulations because of its high filler tolerance. It can be injection molded, extruded and calendered. Specific viscosity: 0.39.

KEY NO. 623

Vinyl Resins Improve Paraffin Wax Coatings

A new series of vinyl resins—copolymers of ethylene and vinyl acetate—has been introduced by E. I. du Pont de Nemours & Co., Inc., Electrochemicals Dept., Vinyl Products Div., Wilmington 98, Del. The new resins impart flexibility and toughness to paraffin wax coatings. Introductory price is 55¢ per lb.

Two grades are available: Elvax 150 and Elvax 250. The grades differ primarily in comonomer ratio and inherent viscosity (see table). Elvax 150 promotes higher specific adhesion and has a lower melt viscosity. Elvax 250 gives tougher, more flexible blends with higher melt viscosities and is more compatible in concentrations below 20%.

A 40% Elvax–60% wax film is

***Paraffin wax** (center) becomes tough and pliable and can be knotted when blended with Du Pont's Elvax vinyl resins. Coatings containing the resins can be bonded to foil (left) and to waxed paper (right).*

For strength
. . . economy
. . . versatility

Steel

NO LARGER GENERATOR SHAFT EVER FORGED ANYWHERE

Shipped recently to the General Electric Company's Large Steam Turbine Generator Department at Schenectady, N. Y., this shaft weighs 233,865 lb and measures 38 ft, 9½ in. long. The shaft will be machined and assembled by G. E. for a turbine-generator unit to serve Tennessee Valley Authority's Paradise Steam Generating Station at Paradise, Ky.

The 116-ton shaft was forged from a 120-inch diameter ingot that required the combined output of five electric-furnace heats, or roughly 260 tons of vacuum-poured, nickel-moly-vanadium steel. It was the largest ingot ever cast in a vacuum by Bethlehem. No larger generator shaft has ever been forged.

The generator shaft was fully heat treated and sonic tested. It has a maximum body diameter of 59¼ in.; minimum diameter of the forging is 11¼ in. The generator will operate at 1800 rpm, providing a maximum output of 391,111 kva.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.
Export Sales:
Bethlehem Steel Export Corporation

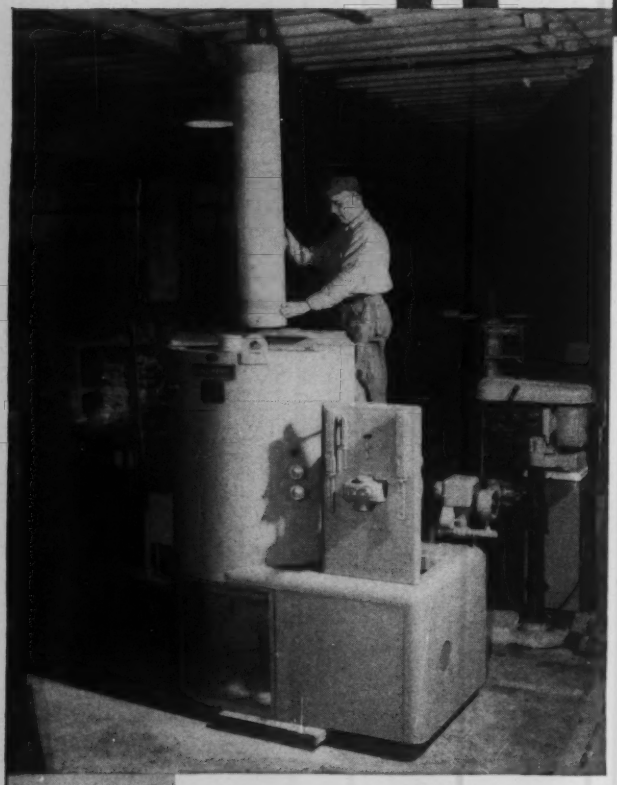
BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, circle No. 379

DURALOY HOM

Covered by U.S. Patents.



Do your high alloy castings show a tendency to sag at 1800 to 2200°F? Is the operation important enough to use an alloy that stays firm at that temperature range?

Then HOM is your casting requirement. It would take an unusually heavy load to deform this metal. It was developed by Duraloy metallurgists to be usable over that high temperature range—another milestone in the ever broadening services available to industry through Duraloy.

Why not discuss your extra high temperature problem with our metallurgical staff?

ALLOY CASTING INSTITUTE ACI MEMBER

Send For Bulletin G-261

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
CHICAGO OFFICE: 332 South Michigan Avenue, Chicago, Ill.
DETROIT OFFICE: 1025 Maple Road, Troy, Michigan
HOUSTON OFFICE: 4101 San Jacinto, Houston 4, Texas

For more information, turn to Reader Service card, circle No. 433

PROPERTIES OF ELVAX VINYL RESINS

Grade ➡	150	250
Comonomer Ratio (ethylene: vinyl acetate), wt %	67:33	71:29
Inherent Viscosity (86 F)	0.78	0.85
Density, gm/cu cm	0.95	0.95
Melt Index	25	15
Refractive Index	1.485	1.482
Softening Pt, F	243	276
Odor	Slight	Slight
Ten Str, psi	1000	2000
Elong, %	700	750

completely flexible at temperatures down to –20 F, and can be elongated 40% before it ruptures. Water vapor transmission rate varies with the ratio of vinyl resin to wax and thus becomes a controllable property.

Tough, flexible bonds to a wide variety of materials can also be obtained with Elvax, either alone or combined with fillers and extenders. The vinyl resins exhibit strong adhesion as the result of chemically active acetate groups in the molecule. Flexibility and toughness result from the rubber-like, noncrystalline structure of Elvax and its high molecular weight. **KEY NO. 624**

Noted briefly in our July issue.

Dry Film Lubricant Useful up to 1200 F

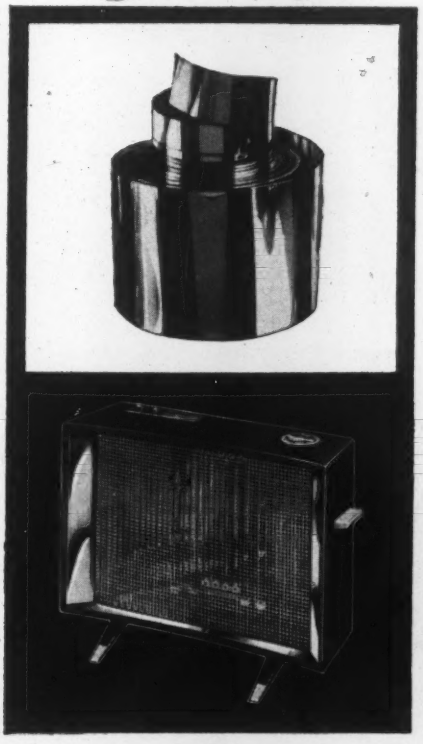
Two new dry film lubricants have been introduced by Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn.

X-15 is an inorganic-bonded dry film lubricant that can be used at temperatures from —300 to 1200 F. It is insensitive to liquid oxygen, retains its lubricating properties under vacuums up to 10^{-9} mm of Hg, and is not affected by up to 5×10^{6} r gamma radiation.

Tests show the lubricant is effective on 1) a thrust ball bearing after 50-hr operation at 840 F, 2) a ball bearing immersed in liquid oxygen for 1 hr at 3600 rpm followed by 350 F operation at 10,000 rpm, 3) a part operated at 10^{-9} mm Hg and 400 F and 10^{-5} mm Hg at 1000 F, and 4) a ball bearing operated at 3500

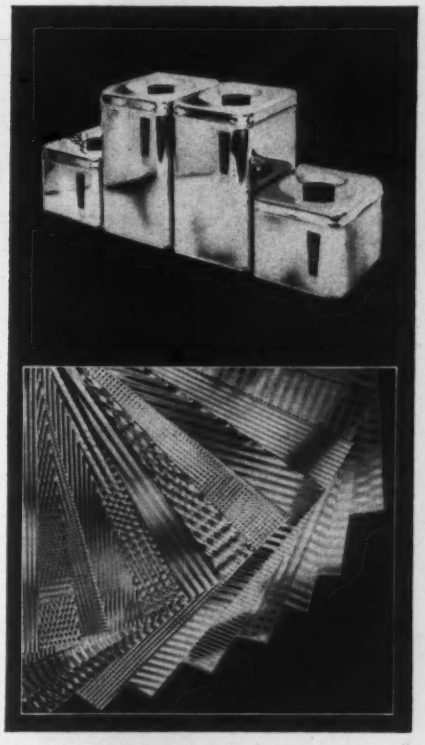
NICKELOID ...THE METAL WITH THE BRIGHT OUTLOOK

A modern metal, a metal for the times . . . functional, beautiful. At home always with high styling; equally responsive when called upon to serve in rough-and-tumble utilitarian and structural assignments. Nickeloid Metals brighten the profit outlook with plenty of eye-appeal and sales-appeal. You can choose from: glinty hard, mirror-like Chromium — soft, mellow, rich-looking Nickel — glowingly warm Copper — radiant, gold-like polished Brass. Nickeloid Metals add a shimmering luster to thousands of products used in home, in office, in commerce. These sheets and coils are pre-finished, ready for mass production.



HEATER

CANISTER SET



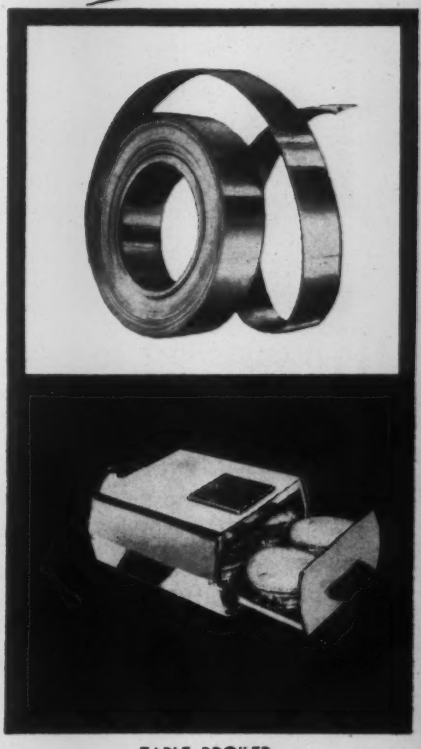


TABLE BROILER

Designer's Paradise

Here are exciting design materials . . . fascinating and versatile. Nickeloid Metals are eager and willing servants in the hands of the expressive and resourceful stylist. Their potentialities are as unlimited as the boundless imagination of the mind itself. The effects that can be created are immensely varied, so very flexible — giving you wide choices in luster, color, texture, patterns. The styling can be lavish or restrained; cool or warm; shimmering or satiny; soft or flashing. New vistas await exploration by the inventive, whether the use be decorative, structural, or for styling detail. Always, Nickeloid Metals are ductile, durable, workable, practical.

Details Sent Free

All who design, style, or manufacture will want to learn more about these versatile metals . . . will want to build a file of product information on the materials comprising the Nickeloid family of pre-finished metals. The data will include specifications and fabrication information. Metal samples for inspection are supplied for your file. Larger working samples for testing or for mockups will be supplied when details of the proposed use are furnished. A sales engineer will be glad to show you exciting new applications, to discuss metallurgical or fabrication problems, to help you develop cost comparisons. A letter will bring complete details.

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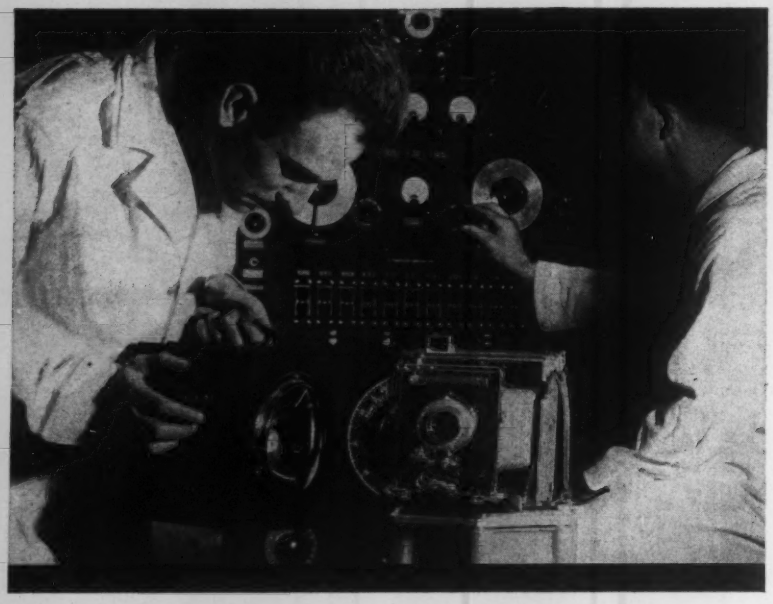
SALES OFFICES in Chicago, New York, Cleveland, Buffalo, Los Angeles, St. Louis, Chattanooga, Boston, Philadelphia, Dallas, Salt Lake City, Seattle, Toronto. *See the yellow pages of your telephone directory.*

For more information, turn to Reader Service card, circle No. 335



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For more information, turn to Reader Service card, circle No. 346

What's new IN MATERIALS

rpm at room temperature for 1000 hr.

Starting torque of the new lubricant at –100 F is 12.5 in-lb, compared to 126 in-lb for conventional –100 F grease.

PVE-K250 is a dry film lubricant designed for use on cutting tools such as gear cutters, reamers and taps. It is easily applied by spraying and requires no surface preparation other than cleaning. **KEY NO. 625**

Two Epoxy Adhesives

Two new epoxy adhesives, a high strength grade and a silver-filled conductive grade, are available from Conap Inc., 184 E. Union St., Allegany, N. Y.

1222 is a 100% solids, two-part adhesive that has a shear strength over 5000 psi for bonds of aluminum to aluminum. The material also provides high shear strengths for bonds of steel to steel and copper to copper. Tests show the adhesive keeps its strength after 30 days immersion in water. It can be used from –65 to 225 F. The adhesive cures in 1 hr at 300 F.

1225 is a moderate-priced, silver-filled conductive adhesive which, when cured, has a volume resistivity of 0.01 ohm-cm at 75 F. Three hardeners are offered for use with the adhesive: one for operation at elevated temperatures, one for curing at room temperature, and one for long pot life. A kit containing 1 lb of 1225 and a hardener is available for $15. **KEY NO. 626**

Hot Work Die Steel Does Not Scale, Check

A new hot work die steel is said to have excellent resistance to scaling and fire checking. The high nickel, chromium-molybdenum steel is also said to have excellent resistance to bursting strains and to erosion from mold washes.

Called Firex Special, the steel is available in a variety of bar sizes from Darwin & Milner, Inc., 2222 Lakeside Ave., Cleveland 14, Ohio.

It is recommended for hot drop

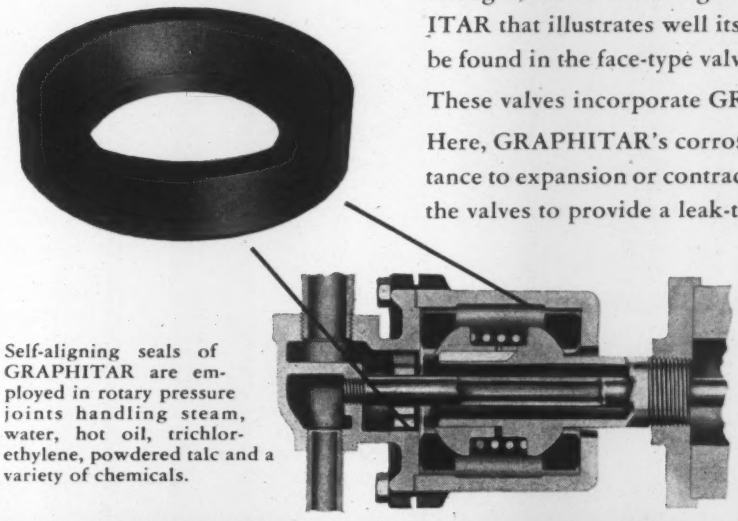
GRAPHITAR®

(CARBON-GRAPHITE)

FOR PERFORMANCE

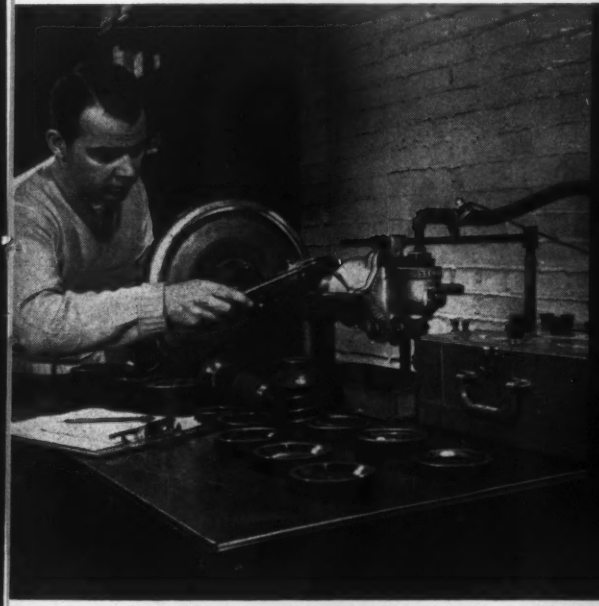
Superior performance and unusually long service life, even in tough applications, is practically second nature to parts made of GRAPHITAR. That's because they combine GRAPHITAR's chemical stability, heat resistance, low coefficient of friction, adaptability to self-lubrication, mechanical strength, hardness and light weight. An everyday application of GRAPHITAR that illustrates well its versatility and remarkable performance can be found in the face-type valves employed in bulk station gasoline meters. These valves incorporate GRAPHITAR seats.

Here, GRAPHITAR's corrosion resistance, chemical inertness and resistance to expansion or contraction under rapid temperature changes, allow the valves to provide a leak-tight seal with excellent wear characteristics. These same characteristics are necessary for good performance wherever steam, gas and chemicals must be handled under the most adverse conditions. Perhaps your product can benefit from the top performance of GRAPHITAR, a unique and versatile engineering material.



Self-aligning seals of GRAPHITAR are employed in rotary pressure joints handling steam, water, hot oil, trichlorethylene, powdered talc and a variety of chemicals.

R-302-1



Comparative testing of various grades of GRAPHITAR self-aligning seals is accomplished on this equipment, which duplicates actual operating conditions. GRAPHITAR rotary pressure joint seals such as these often operate at 400 psi, at 650°F. and at rotary speeds of 600 ft/min.

GRAPHITAR is a material uniquely designed by its nature for solving tough problems and improving processing, and it can be further custom-engineered to meet your exact specifications. For complete information on GRAPHITAR . . . send for Engineering Bulletin #20.

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 3, MICHIGAN

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To get the most out of your barrel finishing

ask Oakite

OVER 50 YEARS CLEANING EXPERIENCE • OVER 250 SERVICE MEN • OVER 160 MATERIALS

"Media-matched" Oakite compounds offer extra barrel-finishing economies

Any experienced barrel-operator can tell you that best results come from the right media and compound "mix"... where media and work are matched; and the compound matched not only to the work but also to the media.

Some signs of a good match: clean and efficient media; enough lubrication to assure a smooth finish; and faster cutting down, deburring and burnishing.

How to avoid a mismatch? That's where Oakite service can help you. Combine the Oakite man's experience with the tremendous variety of acid, solvent, and abrasive Oakite compounds available, and you're sure to be right.

In the complete line, there are compounds for fast cutting... finer finishes... tight tolerances... for steel, brass, aluminum, zinc, lead and various alloys... for hard water or soft. Ask Oakite which is the *right* one to help you get the most from *your* barrel. Bulletin F-9339 tells more. Write Oakite Products, Inc., 26 Rector Street, New York 6, N. Y.

it PAYS to ask Oakite

OAKITE

SCIENCE

over 50 Est. 1909 years' leadership in industrial cleaning

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forging and press forging dies, hot piercing mandrels, hot shear blades and hot extrusion dies.

The steel hardens in air from 1675 F with a minimum of deformation and distortion, according to the producer. Drawing at 950 to 1050 F for 4 hr is said to develop good heat resistance. Hardness after drawing in this temperature range is Rockwell C47. **KEY NO. 627**

Porcelain Enamels Are Alkali Resistant

Three new, improved porcelain enamel groundcoats are said to provide 20 to 40% better resistance to alkalis than presently used materials. A big use will probably be in home laundries and dishwashers.

The developer, Pemco Corp., Eastern & Pemco Aves., Baltimore, Md., says the enamels can be fired over the temperature range 1425 to 1525 F. The blue-black coating produced after firing can be used alone or with a cover coat. **KEY NO. 628**

Nonburning Epoxies for Laminates, Castings

Two new flame retardant epoxy resins have been introduced recently. One resin is designed for use in hot melt castings and dry lay-up laminating; the other for use in adhesives, tooling, laminates and electrical insulation.

ERL-0625 is a flame retardant epoxy available from Union Carbide Plastics Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17. Combined with aromatic amine or anhydride hardeners, the new epoxy forms cured systems with excellent physical, electrical and chemical resistance properties similar to those of conventional diglycidyl ether or bisphenol-A epoxies.

The new resin readily passes the ASTM D635, 30-sec ignition flammability test. For example, an ERL-0625 epoxy–181-weave glass cloth laminate was self-extinguishing in 4 to 7 sec.

Semi-solid at room temperature,

...keeps rockets from burning their tails!

These four Panelyte® nozzle liners insulate against temperatures *in excess of 5000°F.* and resist the erosive effect of supersonic exhausts on America's missiles.

This *one-piece*, high-density molding was "too big to be produced." It's a full 28" wide by 10" deep by 1¾" thick . . . includes separate layers of refrasil and graphite in heat-resistant phenolic resins . . . and is absolutely free of pinholes and voids.

Panelyte's ability to produce such high-pressure moldings has been demonstrated on parts weighing from a few ounces to over 200 pounds. It can meet such unique product requirements because Panelyte has:

- Forty-five presses in the 160-3000 ton range, including presses with daylights of over 100 inches.
- Over two decades of experience in complex mold design.
- Complete facilities for testing both the electrical and mechanical properties of all types of plastics.
- A completely equipped pilot plant for resin studies, impregnation and development of molding techniques.
- Over 200,000 square feet of plant space devoted exclusively to the production and fabrication of high-pressure moldings and laminated plastics.

Our engineering and development group stands ready to work with you in designing and supplying high-pressure moldings and laminates for your particular application.

Why don't you start the ball rolling . . . *now?* Contact the Panelyte Division, St. Regis Paper Company, North Enterprise Avenue, Trenton, New Jersey.

Panelyte also produces laminated plastic sheets, rods, tubes and copper-clad stock, as well as special laminates and fabricated parts.

St. Regis
PANELYTE®

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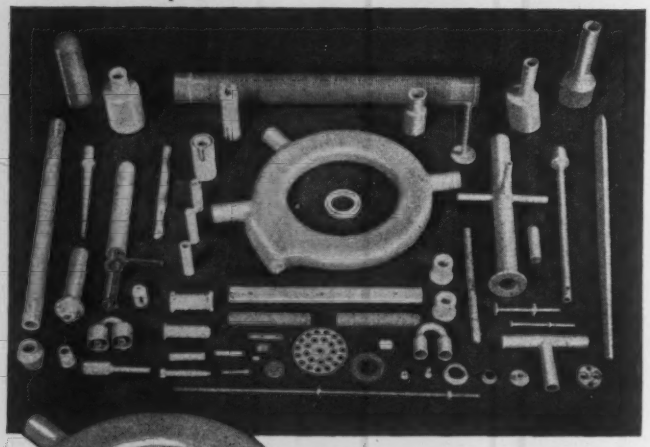
McDANEL

ALUMINA CERAMICS



may be your ANSWER

If you are faced with a tough problem involving high temperature, corrosion, abrasion, chemical action or electronic insulation, McDanel alumina ceramics may be your answer.

McDanel custom produced alumina ceramics are being applied to a wide variety of difficult applications with excellent success.

Send a description of the problem and a sketch of the parts. McDanel engineers are eager to work with you and give you the benefit of their experience and craftsmanship.

Write for Physical Properties Bulletin today.

Write for information today!

McDANEL Industrial CERAMICS

McDANEL
REFRACTORY PORCELAIN COMPANY
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the resin requires moderate heating to become a pourable liquid. It is usually warmed to about 130 F for casting and 150-155 F for laminating.

Noted briefly in our June issue.

KEY NO. 629

DP-440 is the name given to a new flame retardant epoxy resin introduced by Ciba Products Corp., Fair Lawn, N. J. The resin is based on a new series of halogen-containing cycloolefinics. It can be cured at room or slightly elevated temperatures with amine hardeners. Nonburning properties have been verified by the standard testing procedure of ASTM D635. The resin is expected to be used in tooling, adhesives, laminates and electrical insulation.

KEY NO. 630

Other News . . .

Metals

▸ A noble metal thermocouple wire combination has been developed by Engelhard Industries, Inc., Instrument & Systems Section, 850 Passaic Ave., East Newark, N.J. It is said to resist oxidation at temperatures up to 2400 F. The thermocouple wire is designated Platinel 1786 for the positive leg (an alloy of gold, palladium and platinum) and Platinel 1503 for the negative leg (an alloy of gold and palladium). KEY NO. 631

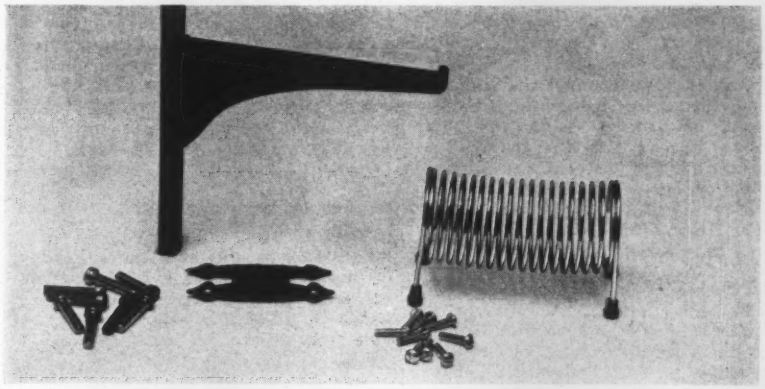
▸ Hollow structural tubing made of hot rolled carbon steel is now available from National Tube Div., U.S. Steel Corp., 71 Broadway, New York 6. It is sold in squares from 1 to 8 in., and in rectangles from 3 by 2 in. to 6 by 4 in. Larger sizes for very heavy construction will be available later. KEY NO. 632

Plastics

▸ A high quality vinyl sheeting for decorative vinyl-to-metal applications has been introduced by General Tire & Rubber Co., Pennsylvania Div., Akron, Ohio. The material, designated Boltaflex 500, is available in thicknesses from 0.010 to 0.020 in. It is produced in a wide range of widths in any color. KEY NO. 633

▸ A clear vinyl tubing has been approved by the U.S. Dept. of Agriculture for use with foods. Available from Samuel Moore & Co., Mantua, Ohio and called Synflex V-1, the tubing is supplied in o.d.'s from ¼

1. A wide range of products can get a better and more protective finish at less cost through zinc finishing.



2. A finishing system consisting of zinc plate, Unichrome Dip Chromate Finish and Unichrome Clear Enamel has been used for 15 years on wire refrigerator shelves made from ordinary steel. It cuts costs, yet gives quality unmatched even by more costly materials.

3. Zinc plated test piece shows protective effect of a Unichrome Dip Finish. Upper portion of sample was treated, lower portion was not. Then the whole part was subjected to standard salt spray corrosion test. Untreated zinc is covered with corrosion; treated surface remains unblemished.

How to transform zinc plate into a finer quality finish

Engineers who consider the requirements for finishing with zinc in terms of a system find that this metal gives a thoroughly satisfactory product finish. And economy, too.

MORE BRILLIANCE: First step in the system is to assure all the brilliance possible from zinc plate deposited on a smooth surface. This is achieved with a plating process such as M&T Bright Zinc which includes a special brightener. Deposits are uniform with remarkable lustre. Coverage is obtained even in deep recesses.

No question about eye appeal at this point. But the brightness wouldn't last. By its nature, zinc left untreated or unprotected would soon tarnish and eventually lose its decorative appeal.

MORE PROTECTION: A chromate treatment is essential for a product finish application. Immersing parts in Unichrome Clear Chromate Dip imparts chromium-like color and brilliance at only a fraction of the cost of chromium. Unichrome Dip finishes are also easily produced in a rainbow of lustrous colors, as well as a glossy and durable black. The corrosion resistance developed satisfies a whole range of standard specifications for chromate finishes.

MORE SERVICE LIFE: For greatly increasing this corrosion resistance, and adding abrasion resistance as well, an organic topcoat such as Unichrome Clear Enamel is good engineering. A product with the eye appeal and proven durability provided by this *complete* M&T zinc finishing system goes out into service equipped to do credit to its designer and justice to its user. Ask for details.

M&T **coatings and finishes**

METAL & THERMIT CORPORATION GENERAL OFFICES: RAHWAY, NEW JERSEY IN CANADA: M&T PRODUCTS OF CANADA LTD., HAMILTON, ONT.

For more information, turn to Reader Service card, circle No. 440

to ½ in. It can be steam sterilized at 220 F for 30 min. KEY NO. 634

Rubber

▸ Color-striped silicone rubber insulated wire and cable is available in AWG sizes 24 through 10 from Boston Insulated Wire and Cable Co., 65 Bay St., Boston 25, Mass. According to the developer, the multicolor markings will not rub off. KEY NO. 635

▸ A new non-milling silicone rubber compound can be fed directly from package to extruded without premilling. Called SE-9008, the compound is available from General Electric Co., Silicone Products Dept., Waterford, N. Y. It is sold as strips 2 in. wide by ½ or ¼ in. thick. KEY NO. 636

Other nonmetallics

▸ A new ceramic material has been developed for use as a base for carbon-deposited and metal film resistors. Designated No. 702, the material is available from Globe-Union Inc., Centralab Div., 900 E. Keefe Ave., Milwaukee 1. It is sold in a wide range of diameters and lengths. KEY NO. 637

▸ A new piezoid ceramic is designed for use in underwater sounding devices, ordnance systems, sensing gages, ultrasonic equipment and other devices. Called Tyzamic-14, the ceramic is supplied as disks, tubes, cylinders, plates and blocks. It is available from Centralab Div., Globe-Union Inc., 900A E. Keefe Ave., Milwaukee, Wis. KEY NO. 638

▸ A mechanical packing construction consisting of braided asbestos yarn impregnated with molybdenum disulfide has been introduced by Abbott & Biddle Co., 2413 Federal St., Philadelphia 45. Called Moly-Pak, the material is available in diameters from ⅛ to 1 in. KEY NO. 639

Finishes

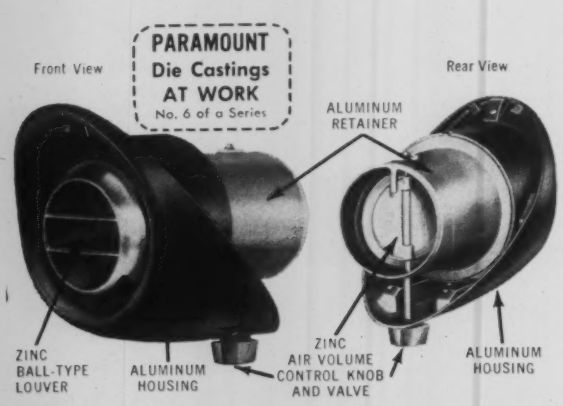
▸ Two new air drying silicone water repellents for use on paper, textiles and leather have been introduced by Silicone Products Dept., General Electric Co., Waterford, N. Y. No. SS-4053 contains a noninflammable solvent and No. SS-4024 contains a flammable solvent. Both materials can be applied by spraying, brushing, swabbing, dip coating and roll coating. KEY NO. 640

▸ An acid-type rust remover suspended in a thixotropic gelling agent is said to cling to vertical surfaces without sagging. Brushed on rusty metal, it removes rust by chemical action and can be flushed off with water. The rust remover, called Aci-Gel, is marketed by Sloan Chemicals, Inc., Caxton Bldg., Cleveland 15. KEY NO. 641

Joining & fastening

▸ A new epoxy adhesive cures in 60 sec at room temperature and can be accelerated to 45 sec by using infrared heat. The resin-hardener adhesive, called Minit-Cure, is available from Allaco Products, Inc., 238 Main St., Cambridge 42, Mass. KEY NO. 642

▸ A new method for soldering and brazing ferrous and nonferrous honeycomb sections has been announced by Murray Hill Research, P. O. Box 73, Murray Hill, N. J. The process, details of which have not been revealed, is said to drastically reduce costs through the use of a noncorrosive flux, thereby eliminating the need for atmospheres, vacuums, and long heating and cooling cycles. KEY NO. 643



PARAMOUNT QUALITY... chosen by Shakespeare Products for this automotive air conditioner part

Quality components make quality products. That's why Shakespeare Products Company chose Paramount to make the zinc and aluminum castings for this air conditioner part for a well-known automobile. Paramount *quality* coupled with engineering and production "know-how" are reasons why **it will pay you to look to Paramount.** Investigate Paramount's complete services *now*.

Three complete plants—two in St. Joseph, Mich., one in Seymour, Indiana.

SEND for "Designing for Die Casting"

PARAMOUNT *Die Casting Co.*

(A subsidiary of TALON, INC.) ST. JOSEPH 5, MICHIGAN

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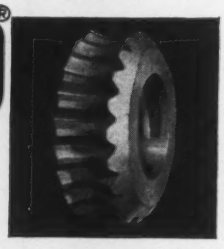
WEAR IS NO WORRY WITH AMPCO® metal

AMPCO metal boom hoist gear for excavating shovel withstands wear, fatigue, shock, and abrasion caused by dust, dirt, and loading.



Bulletin G-60 tells about this series of special copper-base alloys that resist all forms of wear — corrosion, abrasion, erosion, cavitation-pitting. Tells about other characteristics that make AMPCO® metal "the metal without an equal". Send for your free copy today.

AMPCO METAL, INC. Dept. 10J Milwaukee 1, Wis G-1

West Coast Div.: Huntington Park, Cal. • Southwest Div.: Garland (Dallas County), Tex.

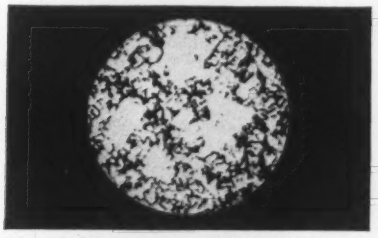
For more information, turn to Reader Service card, circle No. 375

Linde Coatings & materials News

LINDE COMPANY, DIVISION OF UNION CARBIDE CORPORATION

Abrasives, 99.98% pure alumina, simplify polishing of metals

Once it was a complex art to put precision finishes on metals. Polishing, sharpening, honing involved many abrasives and techniques. Now, with LINDE *alumina* abrasives, metallographic polishing is routine.

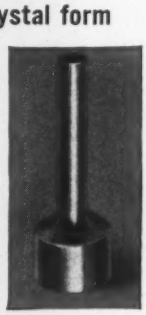


Magnified 1500 X—a sample of tungsten carbide with 6% cobalt binder polished by modified procedure for hard materials. (Murakami's etch).

In three grades LINDE 0.3 A (alpha alumina), LINDE 0.05 B (gamma alumina), and LINDE 1.0 C (alpha alumina)—these low-cost, fast-cutting white powders can be used with many materials. LINDE 1.0 C removes material rapidly; LINDE 0.3 A cuts quickly, yet leaves a clear, unsmeared finish; LINDE 0.05 B cuts slower but produces a finer finish. Uniformity of the particle size eliminates levigation in finishing.

Powders can be used dry, or mixed with water or other vehicles to make a thin slurry or heavy paste, or compounded with waxes in convenient stick form. Both are highly resistant to common acids. Check, send the coupon.

Now—high workability for tungsten in crystal form



Ingots of LINDE crystal tungsten can be worked into intricate shapes for electronic, other applications. It can be done at room temperature, using standard machine tools. Metal has no porosity, relatively low impurity, is less brittle than PM tungsten. Crystal tungsten also has unusual ductility, has been drawn into wire as fine as 1 mil for greater yield of finished product from starting ingot. Check, send the coupon for details.

High-grade wear from lower-grade metals —with tungsten carbide coatings

Bearings on the torque meter shaft of a turbo-prop aircraft engine gave only 50 hours operating life, even though the bearings were heat-treated. The short life was caused by severe fretting corrosion. Then the bearing surfaces were given a tungsten carbide coating with LINDE's Flame-Plating process. Service life is now greater than 1500 hours.

A critical tolerance had to be maintained between a ball piston and the piston wall in a hydraulic pump. Carbide inserts mating with steel balls proved unsatisfactory due to differential expansion at operating temperature. Carbide balls added considerable weight. The problem was solved with Flame-Plated steel bushings which had the correct expansion rate and a wear resistance equal to solid carbide—at considerably less weight.

Aluminum toughened

In another situation, aluminum rocker arms were being used in an aircraft heater mechanism to keep weight under overall requirements. But, because of severe sliding abrasion, the relatively soft metal lasted only about 100 hours. When the wearing surface was given a precision coating of tungsten carbide, service life jumped to more than 1000 hours. And the desirable light weight of aluminum was not lost.

These are typical examples of how LINDE's custom-coating service can be used to upgrade many ordinary metal parts by coating their wearing surfaces with tungsten carbide, aluminum oxide, tungsten, molybdenum, other oxides and materials. The thin coatings multiply wear performance many times over—but at the lower costs and with the retention of the other desirable properties associated with the base metals.

If you need technical information on particular problems with wear caused by abrasion, corrosion, erosion—even under conditions of severely high temperature, high load, or absence of lubricant or cooling—LINDE can help you. Check and send the coupon below.

PHYSICAL DATA—FLAME-PLATED COATINGS

COATING DESIGNATION	LW-1	LW-1N	LW-5	LC-1A	LA-2
Approx. Composition by weight	Tungsten Carbide + 6% to 8% Co	Tungsten Carbide + 13% to 16% Co	25% WC + 7% Ni + mixed W-Cr Carbides	85% Cr_3C_2 + 15% Ni-Cr	99% + Al_2O_3 (gamma)
Hardness Vicker's (VPN_{100})	1200 to 1450	1050 to 1150 VPN 70 to 71 R.	1000 to 1200 VPN	850 VPN	1000 to 1200 VPN
Maximum temp. in oxidizing atmosphere	1000°F.	1000°F.	1400°F.	1800°F.	1200°F. to 1800°F.
Coefficient of thermal expansion	4.0 x 10 ⁻⁶/°F. Avg. 70 to 1000°F.	4.7 x 10 ⁻⁶/°F. Avg. 70 to 1000°F.	4.6 x 10 ⁻⁶/°F. Avg. 70 to 1400°F.	6.4 x 10 ⁻⁶/°F. Avg. 70 to 1800°F.	3.9 x 10 ⁻⁶/°F. Avg. 70 to 1832°F.
Modulus of Rupture	67,000 psi	80,000 to 106,000 psi	40,000 psi	75,000 psi	22,000 psi
Modulus of Elasticity	44 x 10⁶ psi	42 to 40 x 10⁶ psi	17 x 10⁶ psi	22 x 10⁶ psi	16 x 10⁶ psi
Porosity	0.5%	0.5 to 1.0%	0.5%	0.5%	1.0%
Specific Gravity	14.2	13.2	10.1	6.54	3.45
Specific Heat	0.048	0.056	0.070	0.127	0.196
Thermal Conductivity	5.3 at 500°F.	5.3 at 500°F.	3.8 at 500°F.	4.3 at 500°F.	0.86 at 500°F.
Main features	Extreme wear resistance	Excellent wear resistance + increased resist. to mechanical and thermal shock.	Excellent wear resist. to higher temps. Improved corrosion resist.	Good wear resist. at high temp. or in corrosive media. Resists flame impingement.	Excellent resist. to wear, chem. attack and high temperature deterioration.

CHECK—CLIP COUPON—ATTACH TO BUSINESS LETTERHEAD

Linde Company, Dept. MI-10
270 Park Avenue
New York 17, N. Y.

Please send details on the items checked:

- ☐ LINDE Flame-Plated Coatings
- ☐ LINDE Alumina Abrasives
- ☐ LINDE Arc Crystal Tungsten

UNION CARBIDE

LINDE COMPANY

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For more information, turn to Reader Service card, circle No. 426

Spaulding **FIBRE FACTS FOR ENGINEERS** NUMBER 4

How to Punch Vulcanized Fibre to Reduce Fabrication Costs

by K. H. Alverson, Product Standards Director

Vulcanized Fibre's capacity for easy punching makes this material highly attractive to the designer whose application calls for characteristics such as good dielectric strength, light weight, rugged strength, irregular contours and holes and indentations in the surface of a part.

Punching is done with two kinds of precision: Rough punching uses the lowest cost solid dies, is rapid and economical, but leaves a fractured raw edge and is limited to stock thicknesses through ¼ in.; smooth shaving uses a contour die ground to a sharp edge that slopes away at 45°. The edge shaves stock when the part is forced into the die producing smooth edges in parts up to 1 in. thick. Holes can be punched easily, but should be generally spaced from each other and from any edge by at least the thickness of the stock. Noncircular holes and counterbores should be made circular for machining when the stock thickness specified is too thick to punch.

For thickness under 3/64", vulcanized fibre can be punched most economically with steel rule dies. Dies for simple parts usually cost much less than solid dies even for irregular contours. Tooling for scoring or creasing can also be added with little additional cost.

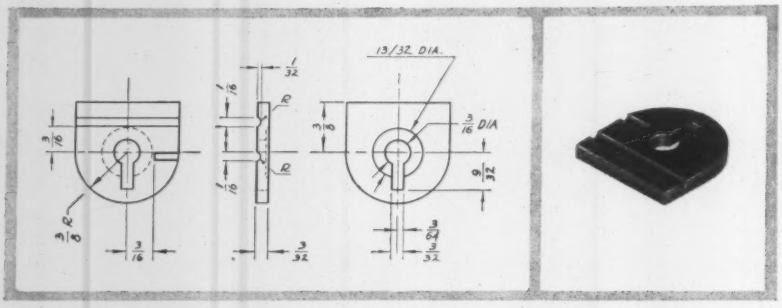
Most parts can be punched without additional conditioning if the vulcanized fibre has its normal moisture content of 5½ to 7%. For especially difficult punchings, or for parts thicker than ⅛", heating up to 200°F may be desirable.

Additional economies may be obtained in thicknesses 1/16" and under by using coils slit from parent rolls, reducing waste of stock, speeding up the punching operation, and reducing inspection costs.

Many extras may be incorporated in punching operations on vulcanized fibre. These include scoring or creasing for subsequent forming along established lines. Also practical are swaging or forming into special shapes, such as shoulder bushings or angles.

Stamping letters and numerals into the surface of vulcanized fibre in the punch-press operation produces permanently legible markings with no increase in cost of the part. White or colored roll leaf characters can also be impressed into the surface to give color contrast at very little added cost. Punched parts are also readily printed with rubber stamp.

Spaulding Engineers who have been trained in Value Analysis can help you take advantage of the wide range of possibilities in designing to reduce costs through the use of vulcanized fibre parts. They also make available to you Spaulding's extensive fabricating facilities and experience in working with this extraordinary material.



The fabrication of this shut-off switch insulator demonstrates vulcanized fibre's facility for punching and swaging. Previously moulded out of nylon, the part is now made by swaging both sides and punching vulcanized fibre — all in the same operation and at lower costs both for material and processing.

Send for your FREE copies of this literature

Value Analysis Brochure — case histories of design improvement and cost reductions that have been accomplished through Spaulding's value analysis of customer products.

Vulcanized Fibre Engineering Data — a design reference book which comprehensively covers all the application specs of vulcanized fibre.

SPAULDING FIBRE COMPANY, INC.

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See our Display at the Design Engineering Show, Booth 939

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(cont'd from p 110)

Cavitation Resistance Studied

New data on the relationships between the cavitation erosion resistance of metals, ceramics and plastics and their physical structures are being determined in a U.S. Navy research project. Hardness, tensile and yield strengths, and elongation appear to have the most effect on erosion resistance.

The experiments were described by J. Z. Lichtman, D. H. Kallas, C. K. Chatten, New York Navy Shipyard, and E. P. Cochran, Jr., Office of Naval Research, at the 1961 annual conference of the National Association of Corrosion Engineers in Buffalo, N. Y.

Rotating disk test used

The test consisted of spinning 12-in. dia specimen disks in a tank of water. Cavitation erosion was induced on the specimen surfaces by turbulence from small holes or inserts in the disk at different radii. Stilling vanes minimized rotation of the water in the tank.

High speed photography was used to study the formation of cavitation clouds and eroded areas at various speeds and hydrostatic pressures. Results are as follows:

Metals—There was no general correlation between cavitation erosion resistance of metals and their hardness, tensile or yield strengths, or ultimate elongation except for the differences between extremely hard and extremely soft metals. For example, Stellite 6B of 405 Bhn is over 600% more erosion resistant than aluminum 1100-O of 80 Bhn. Resistances of moderately hard metals such as bronze, stainless and mild steels, brass and monel alloys did not correlate directly with their hardness or other mechanical properties. It is likely that other factors, including metallurgical ones relating to processing and chemical composition, as well as high frequency fatigue characteristics and impact strength, are important.

Ceramic and flame-sprayed coatings —Unfused ceramic and metallic coatings have low erosion resistance. This is probably due to their heterogeneity as contrasted to glasses and fused metallics. The high erosion resistance of hard fused coatings confirms hardness as a factor in erosion resistance.

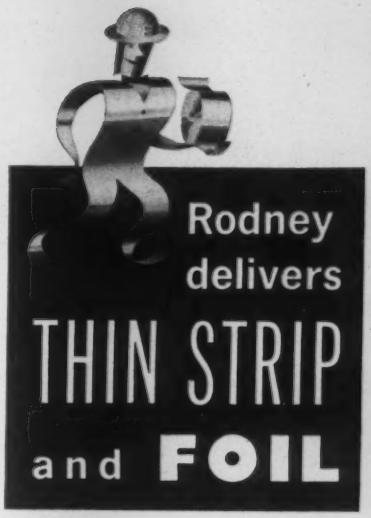
Elastomeric coatings — Erosion resistance of elastomeric coatings having high tensile strength, ultimate elongation and tearing strength is even greater than that of very hard metals and ceramics. This resistance probably depends on all three factors and on the elastomer's ability to recover after the impacts of cavitation bubbles.

Plastics — Ultimate elongation appears to be significant in determining the erosion resistance of plastics. For example, molded nylon sheet having a water content of 2.5% has a reported ultimate elongation of 300%; this material has higher erosion resistance than other plastics such as PVC and styrene-acrylonitrile, which have substantially lower ultimate elongation.

New Columbium Alloy Data from Russia

Columbium is strengthened at high temperatures by alloying with elements with which it forms 1) homogeneous solid solutions, or 2) supersaturated solid solutions in which an excess phase is precipitated, according to recently published Russian data.

Five different alloys, which have no reported American counterparts, were prepared with various combinations of molybdenum, zirconium, silicon, aluminum and carbon. Compositions and comparisons of hardnesses (and thus, indirectly, strengths) of the alloys and pure columbium are given in the accom-



Precision Thinness in Stainless and Special Alloys...

Rodney concentrates its entire efforts, research and production, toward furnishing super thin, extra wide, precision rolled, metal strip and foil in all tempers and finishes. With the entire capacity of plant and personnel devoted exclusively to this specific area, Rodney can offer the added "know-how", manufacturing experience, quality control, and application knowledge your operation may require.

Rodney produces stainless steel strip . . . all alloys . . . in widths from ⅛" to 24" . . . at gauges from .012" to .0003". Rodney also rolls high temperature alloys and other special alloys on a production basis. Aluminum alloys, carbon steel strip and specialty custom rolling are also handled.

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West Coast Office & Warehouse:
5462 East Jillson St., Los Angeles 22, Calif.

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Solid Platinum Anode Performance at 1/10th the Cost

PLATANIUM® ANODES

PLATANIUM ANODES, made from titanium mesh coated with a uniform thickness of platinum by the PLATANEX* Plating Process, are equal functionally to solid platinum anodes yet cost less than 1/10th as much.

Thanks to a unique diamond configuration design, PLATANIUM ANODES give maximum anode area while cutting down over-all size 50% or more.

PLATANIUM ANODES are recommended for a wide range of electrolytic operations—from electroplating to refining or chemical processing—wherever insoluble anodes are indicated.

We're in full production and can offer immediate shipment of PLATANIUM ANODES in practically any size or quantity required.

Our technical bulletin PLT-1 gives details and price information.

*Trademark, patent applied for.

Sel-Rex **SEL-REX CORPORATION**
NUTLEY 10, NEW JERSEY

The world's largest selling precious metal electroplating processes

For more information, turn to Reader Service card, circle No. 370

In coils. Thicknesses from .020 to .070 in., widths of 2, 4, 6, 8 in. Ideal for punched parts under static or dynamic loads (gaskets, washers, closure liners, etc.).

See your nearest Hyde distributor or write for complete information.

A. L. HYDE CO.
Established 1932
Dept. MDE-10 Grenloch, New Jersey
Member Plastic Pioneers
DISTRIBUTORS FROM COAST TO COAST

in stock at HYDE'S distributors
DELRIN* 500 ROD · SLAB · STRIP HEAVY-WALL TUBE
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ZYTEL* 31 LEXAN† polycarbonate IMPLEX** A ROD AND SLAB

*Du Pont trademark
†General Electric trademark
**Rohm & Haas trademark

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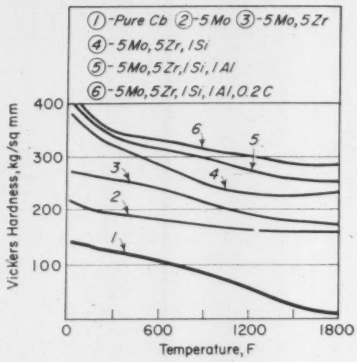

Hardness vs temperature *is compared for columbium and five of its alloys.*

panying graph.

The original data were published by I. I. Kornilov and R. S. Polyaka, *Atomnava energyra*, 10,2, Feb '61, pp 170-172. The abstract is contained in the May 26, '61 issue of *Current Review of the Soviet Technical Press*, Office of Technical Services, Dept. of Commerce, Washington 25, D.C.

Glass-Polyester Shaft for Better Golf Scores

The first golf club shafts made entirely of reinforced plastic are being produced in three degrees of stiffness to suit individual preferences. They are said to give golfers more distance and control in their drives.

Impregnated with a polyester resin, 500,000 glass fibers run the full length from hands to the club head and are said to give a close "feel" between the golfer and the ball. The fast response action of this material keeps the club in contact with the ball longer, resulting in longer, straighter drives, according to tests run by Shakespeare Co., which developed the shaft.

An epoxy resin coating gives the shaft a hard shiny surface which is impervious to the corrosive action of salt air and high humidity. The glass fiber is produced by Owens-Corning Fiberglas Corp.

(more ME&D on p 178)

For more information, circle No. 422 ➤

ANOTHER PRODUCT OF REICHHOLD RESEARCH

NEW! POLYLITE POLYESTER METAL FINISHES

Now, you can offer maximum metal surface protection with a durable plastic coating. Formulate "self-baking" protective and decorative paints with RCI POLYLITE polyester resins.

You can offer ease of application. Coatings 15 mils thick can be readily sprayed on vertical surfaces **in one application,** using a dual spray gun. The paint cures rapidly to a durable, chemical-resistant finish.

Comparative tests show these polyester paints to be equal to or better than other metal finishing systems. And the cost-per-mil-per-square-foot is lower!

Paints made with POLYLITE resins are extremely versatile, may be developed to perform over a wide range of requirements. They require no different treatment in manufacture from conventional flat wall paints or gloss enamels.

Write for complete information, suggested formulations and data on metal surface preparation and priming, to: Reichhold Chemicals, Inc., RCI Building, White Plains, N. Y.

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Have You Explored GRAPHITE As A Problem-Solving Material ?

Are you looking for an economical substance that combines machineability, chemical inertness, high thermal conductivity, high temperature stability, and resistance to thermal shock?

Are you looking for a material that has proved to be highly suitable for such diverse applications as vital nuclear reactor components, molds and dies for metals casting, sintering boats and trays, run-out tables and canisters, refractories, brazing fixtures, linings in chemical process equipment, thermocouple shields, and electric resistance furnace parts?

For an introduction to the excellence of GLC graphite—and to one of the world's outstanding graphite producers—write for a free copy of our illustrated brochure, "Graphite For Diversified Industrial Application".

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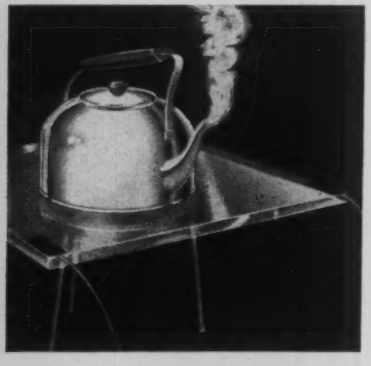
ADVERTISEMENT

GLASS ELECTRICAL CONDUCTOR

Transparent vacuum-deposited coating makes glass a resistance heating element



Among vacuum-deposited coatings made by Liberty Mirror is a transparent electrical conductor, *81-E*®, for defogging or deicing optical surfaces and instrument faces, camera windows, prisms, lenses and other optical elements.

81-E has a resistivity of approximately 30 ohms per square area and visible light transmission of approximately 75% when applied to plate glass. These properties can be changed within limits.

Other vacuum-deposited coatings of aluminum, chrome and gold are used to make first-surface mirrors, neutral filters, transparent mirrors, high-efficiency beam splitters, beam-splitting dichroic mirrors and filters.

Applied to glass, metal or plastic, the coatings are used in such varied products as scientific and optical instruments, toys, cameras, pin setters, wheel-aligning equipment, aircraft and missiles. If you have a potential application or new use, Liberty Mirror engineers will help you solve your problems. Technical data sheets available on all coatings. Write Liberty Mirror Division, 23101 Libbey-Owens-Ford Building, Toledo 1, Ohio.

For more information, turn to Reader Service card, circle No. 367

MATERIALS ENGINEERING & DESIGN

Cold Columbium Ball in 'Most Accurate' Gyro

A new inertial guidance system, designed to operate with greater accuracy than has ever before been obtained, is being built around a pure columbium sphere less than 2 in. in dia.

The ball will rotate as the heart of a gyroscope while it is held at a temperature near absolute zero. In this state, columbium loses virtually all electrical resistance. This allows the spinning ball to be suspended by a magnetic field, eliminating the mechanical friction which is one of the main sources of gyroscope error. Evacuating most of the air around the sphere will remove gaseous friction.

Out-of-roundness, another potential cause of error, will be minimized by superfinishing the columbium ball to a "roundness" tolerance of 10 millionths of an inch. Several months of delicate shaping are required to arrive at this degree of accuracy, according to General Electric Co., which is developing the new guidance system.

Filament Winding Resin for High Temperatures

A new epoxy novolac resin system appears to offer the best combination of performance and processability so far achieved for high temperature filament wound structures.

Typical filament wound test specimens have hoop tensile strengths as high as 11,000-175,000 psi at 500 F when loaded at 115,000 lb per min.

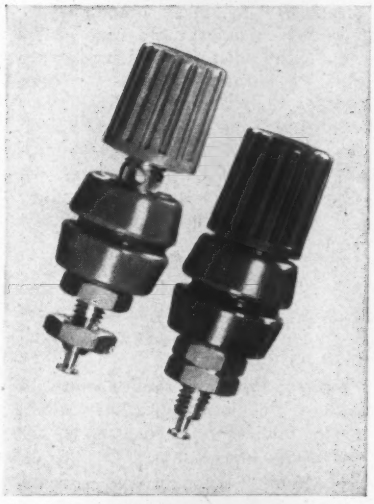
The new resin system has been tested by Narmco Industries Inc., subsidiary of Telecomputing Corp. The system consists of Dow Chemical Co.'s epoxy novolac resin, DEN 438, catalyzed with methyl "Nadic" anhydride and DMP-30.

Evaluation of the system was reported by J. V. Kindall and S. E. Susman of Narmco at the recent symposium on Filament Winding sponsored by the Society of Aerospace Material and Process Engineers.

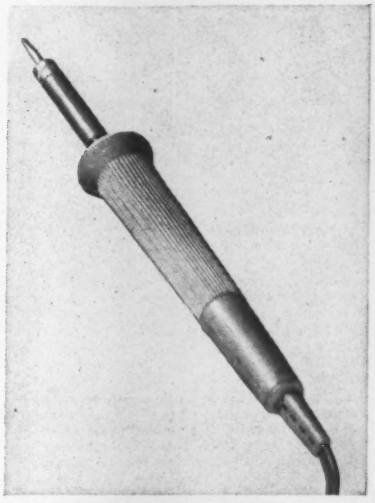
Epoxy novolac resin systems have

G-E LEXAN® POLYCARBONATE RESIN

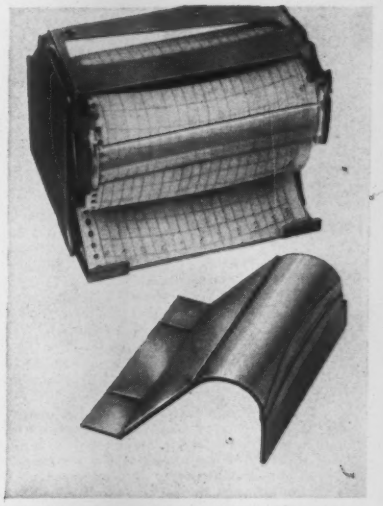
GOOD DIELECTRIC—AND MUCH MORE!



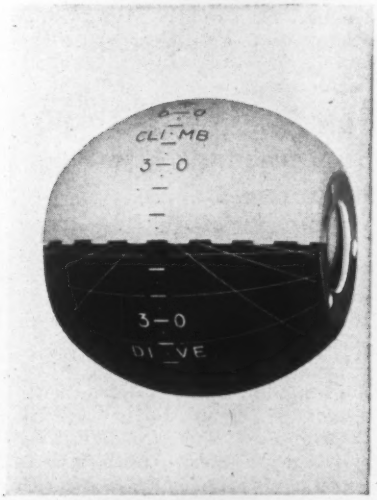
STABLE ELECTRICALS. Binding posts made of LEXAN resin retain electricals even under moist, hot conditions. They do not loosen, are molded in six attractive LEXAN colors for coding. Other features are: low loss and power factor, low dielectric constant, high voltage insulation, non-sink surfaces.
(Superior Electric)



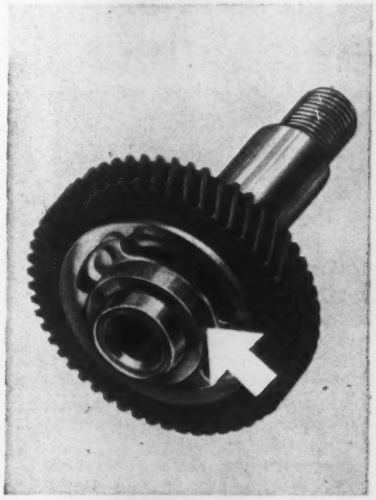
HEAT RESISTANCE. Beautiful handles of LEXAN polycarbonate resin are used in rugged service on U.L. approved soldering irons. They resist the impact, heat and abrasion of daily bench work. The hard, glossy handles are light in weight. Molded in three pastel colors, they provide toughness and sales appeal.
(Ungar Electric Tools)



TRANSPARENCY of LEXAN resin is important in chart guide for recorder. LEXAN resin is the only transparent plastic able to withstand heat generated by internal lights. It is distortion-free at temperatures up to 270°F and self-extinguishing. Its extremely high impact strength eliminates cracking of guides.
(The Foxboro Co.)



DIMENSIONAL STABILITY. Maximum allowable change in this 5-inch aircraft instrument part is only 5 mils over a temperature range of —65° to 300°F! And it must maintain this tolerance under high humidity. Part is injection molded of LEXAN resin as half spheres which are solvent cemented, lathe-turned and painted. (Lear, Inc.)



TOUGHNESS. Press-fitted into metal gear used in an electric drill, bushing of LEXAN polycarbonate resin provides safety from electric shock . . . helps eliminate need for additional grounding. Strength and creep resistance of LEXAN resin enables bushing to withstand torque and load requirements of drill.
(Millers Falls Co.)

ARE YOU LOOKING FOR A PLASTIC THAT CAN REALLY TAKE IT?

To demonstrate the toughness of LEXAN resin, salesmen will sometimes slam and hammer a product made of the material. LEXAN has the highest impact strength of any plastic – amounting to 12-16 foot-pounds per inch of notch – and it usually emerges unscathed from encounters with such "merchandising stresses". It is a high-performance material, likewise, with regard to high-temperature behavior and dimensional stability.

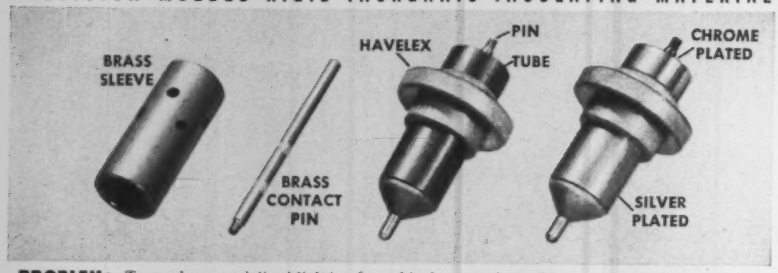
Its many other advantages make it a priority material for thorough investigation by all designers, engineers and molders. We will be pleased to supply you with information on the properties, processing and end-uses of LEXAN resin. Don't hesitate to write to us. General Electric, Chemical Materials Department, Section MDE-101, Pittsfield, Mass.

LEXAN®
Polycarbonate Resin
GENERAL ELECTRIC

For more information, turn to Reader Service card, circle No. 383

Here's How Haveg Solved the Problem... with HAVELEX®

PRECISION MOLDED RIGID INORGANIC INSULATING MATERIAL



PROBLEM: To produce specialized lighting for vehicular tunnels, underpasses, walkways, marquees, and other places where severe ambient conditions exist (i.e., temperature, fog, spray, exhaust fumes, etc.) but where ease of servicing is vital.

SOLUTION: Haveg engineers working closely with The Simes Company, College Point, Long Island, New York, created a double contact insulation unit which permits energizing of fluorescent tubes sealed in glass jackets *from one end only*.

Double electrical contact was achieved by molding an outer brass tube (1¼" diameter) and a center brass contact pin (¼" diameter) integrally insulated with enduring Havelex. Chrome and silver plating was applied (after molding) to selected areas of the exposed brass to further enhance operating characteristics.

Haveg engineers welcome the opportunity to work with you on your particular project —to help you "Keep ahead with Haveg." Remember—Havelex offers all of these unique features: **Dimensional Stability • 1000°F. Continuous Temperature Resistance • Dielectric Strength • Mechanical Strength • Low Loss, Low Power Factor • Arc Resistance • No Moisture Absorption • Integrally Molded Metal Inserts • Hermetically Sealed Inserts.**

Please address inquiries to Sales Manager, Havelex

Keep Ahead with HAVEG. FIRST IN *Engineered* PLASTICS

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For more information, turn to Reader Service card, circle No. 330

High Purity CRUSHABLE CERAMIC PREFORMS meet Government Specs.

Crushable ceramic preforms for precision swaged thermocouples for atomic energy and turbine engine applications are available from Carborundum.

The following materials exceed the requirements of A.E.C. Specification SPC-SR-101-(ORO), Oak Ridge National Laboratories Specification ORNL Spec. 7444-1 and Knolls Atomic Power Laboratories ORPM 7-1.

1. *High Purity Magnesium Oxide*—Type 0333, certified purity 99.4% min. MgO and less than 25 ppm boron.

2. *High Purity Fused Aluminum Oxide*—Type 1513, certified purity 99.6% min. Al_2O_3 and less than 2 ppm boron.

3. *Stabilized Zirconium Oxide*—Type 0956, certified purity 91.9% min. and less than 10 ppm boron.

Standard sizes are from .022 O.D. with holes from .005. Standard preforms are offered for 1, 2 and 4 hole applications. Others are available on request.

For Technical Data Sheet and other information contact Dept. MD-101, Latrobe Plant, Refractories Division, Carborundum Co., Latrobe, Pennsylvania.

CARBORUNDUM®

For more information, turn to Reader Service card, circle No. 388

excellent mechanical properties at moderate temperatures and their high heat distortion temperature (568 F) permits superior performance at high temperatures.

In an evaluation of several resins, the DEN 438/MNA/DMP-30 system was found to provide the best compromise between processability and composite physical strength.

Composition vs properties

Varying resin composition and content was formed to affect properties of the filament wound specimens as follows:

- Variations in the amount of catalyst do not significantly affect tensile and shear strengths of the specimens.
- Although good wound composites were made with the resin at room temperature, some complex configurations might make it desirable to heat the resin to cut its viscosity during impregnation.
- Unidirectional filament wound structures containing about 20% resin have optimum hoop tensile strength. Equivalent ring stress values are obtained with 10 to 20% resin.
- Interlaminar shear strength varies with resin content up to 750 F where shear strength becomes essentially constant with increasing resin content.

Supermendur Lightens Inductive Cores

Considerable weight saving in missile and aircraft electrical systems can be gained by making inductive cores of Supermendur alloy which is now becoming commercially more available (see p 131).

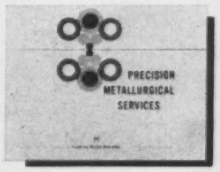
The high flux density at which Supermendur can be operated allows weight reductions up to 30% in transformers. This is indicated by Westinghouse Electric Corp. tests in which a Supermendur core equal in weight to a grain-oriented silicon core produced a much higher rate of power. Magnetic modulators, filter chokes and other inductive components are also likely applications for

Based on a report by M. Lauriente and R. E. Lee, Air Arm Div., Westinghouse Electric Corp.

"We wanted nickel-chromium ingots rolled to foil .0005" ± .00005" thick with a width of .188" ± .001" x coil, with a breaking load of 7 to 9 lbs., and a blemish-free mirror finish. Hamilton did it for us."

says T. J. Scanlon, Purchasing Agent, Electron Tube Division
Radio Corporation of America, Harrison, New Jersey

PRECISION IS OUR PROVINCE. Working to minimum thickness of .00008", mimimum widths of 1/32", Hamilton can supply you with foil or strip . . . rod or wire . . . of virtually any alloy in production quantities. Our full-scale, completely-integrated facilities and engineering talent in this field permit absolute quality control from melt to finish. Thanks to these capabilities . . . a familiarity with precision work inherited from Hamilton's watchmaking background . . . experience with ultra-thin foils unmatched anywhere in the world . . . we offer you precision metals to meet your exact property and delivery requirements. We guarantee our product. Call us.



For additional information on Hamilton's facilities and capabilities, send for free booklet, "Precision Metallurgical Services." Write Dept. 3110, Metals and Electronics Div., Hamilton Watch Co., Lancaster, Penna.

HAMILTON WATCH COMPANY

Metals and Electronics Division, Lancaster, Penna.

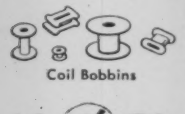
For more information, turn to Reader Service card, circle No. 431

GRC tiny parts

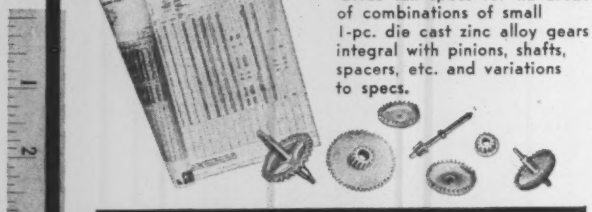
Die Cast
ZINC ALLOY
Molded
PLASTICS

Die Cast Zinc Alloy

Molded Nylon, Delrin & Other Engineering Thermoplastics


Coil Bobbins

Gears & Pinions



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Gives full specs for hundreds of combinations of small 1-pc. die cast zinc alloy gears integral with pinions, shafts, spacers, etc. and variations to specs.

GRC's unique high speed, automated methods give you high quality, uniformly accurate small parts in die cast zinc alloy or molded Delrin, Nylon and other engineering thermoplastics . . . ***at low cost.*** GRC experience and exclusive techniques open the way to new design freedom, new production and assembly shortcuts. Write, wire, phone NOW for samples and detailed bulletins. Send prints for prompt quotation.

NO MINIMUM SIZE: Maximum sizes:
Zinc Alloy—2" long, ½ oz.
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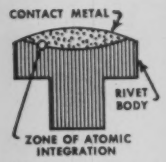
Gibson Atomiclad* Electrical Contact Rivets now available in economical Gibson Assemblies

ATOMICLAD RIVETS ARE LOWER COST BECAUSE IT COSTS LESS TO MAKE THEM



Patents Pending

And they're BETTER because their bond of dispersed atoms of the precious contact metal and the base metal of the body is electrically and mechanically superior to other bonding methods. Cost is further reduced by limiting use of precious metal to electrical requirements of the contact.

Atomiclad Rivets are made in all standard forms and of copper, steel or other base metal with contact face of precious or semi-precious metals.

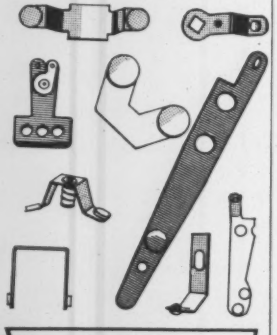
Many sizes and types are stocked in quantity. Write for Standard Stock List #2007, and for Technical Information Bulletin 400.

ECONOMICAL GIBSON CONTACT ASSEMBLIES

Gibson contact support manufacturing facilities include every phase—forming, riveting, heat-treatment and electroplating and comprises use of any specified metal.

When you specify Gibson Contact Assemblies, you get the benefit of years of engineering know-how in providing the best possible electrical union between contact and support member. Since all assemblies are Gibson-inspected, the customer suffers no loss through assembly rejects.

Gibson Engineers will design your complete contact assembly upon receipt of specifications. Or send your drawings for fabrication costs. If you prefer your own support member, send a sample for assembly cost.



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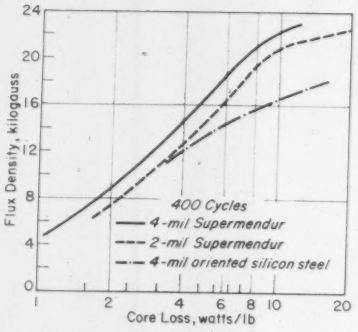


Performance *of Supermendur vs grain-oriented silicon steel.*

this material. It is made up of 49% iron, 49% cobalt and 2% vanadium.

Supermendur has lower core losses than the best grades of oriented silicon steel at high inductions. It is characterized by low coercive force, low hysteresis loss, high permeability and high remanence.

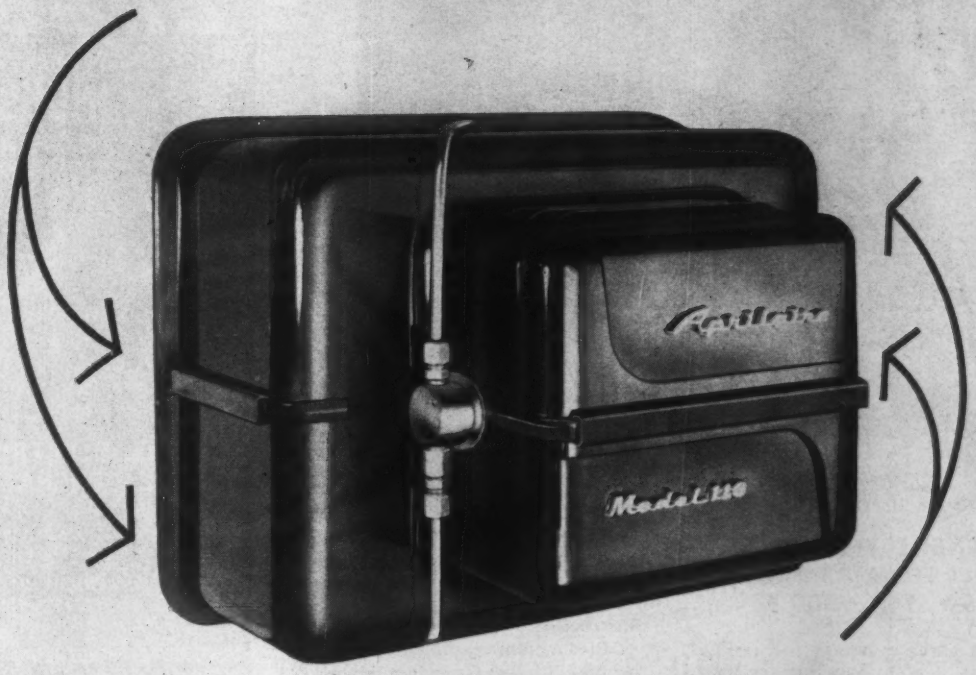
Greater power output

Performance tests of toroidal transformer cores have been conducted to compare oriented silicon steel with Supermendur. The materials used for the cores were cold rolled 0.002 and 0.004-in. tape made by Westinghouse. The transformers were constructed essentially the same for comparison purposes. They were tested with the same input and output voltages.

The Supermendur transformer produced 25% greater power output than the oriented silicon steel transformer. Comparative performance data are shown in the accompanying graph. The transformer with the Supermendur core had a higher exciting current in these tests. However, this did not significantly increase the overall primary current when using the component as a power transformer.

Plastic Cuts Weight of Aircraft's Nose Tip

A propeller hub housing subjected to vibrational stresses, centrifugal force and intermittent heating is being produced using epoxy-fiberglass



Humidifier CMPC-molded for lifetime service

The Aprilaire® high-capacity furnace humidifier will never have a problem from heat, rust or corrosive impurities of water. Manufactured by Research Products Corporation, it's housing is of CMPC-molded special-purpose phenolic . . . designed to permit easy accessibility for inspection and maintenance if necessary. The motor housing, drain pan and distributing pan are all integral molded-in parts of the neat, compact main housing. A bonus feature is soundproofing—helping make the unit whispering quiet.

To improve your products, or to meet one of those "difficult" manufacturing situations where a plastic is the answer—see your Chicago Molded Engineer . . . He'll have the solution for you!

Send for new brochure "Design and Purchase of Custom Molded Plastics".

CMPC

CHICAGO MOLDED PRODUCTS CORPORATION
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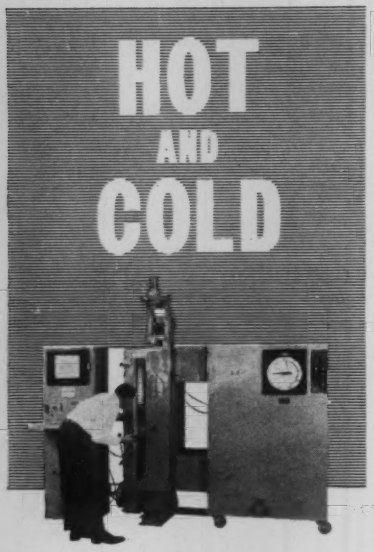


TENSILE TESTING OF ELASTOMERS FROM −90° TO +600°F

Here's the complete package for testing elastomers at both high and low temperatures! Model L-8 offers the combination of a full-length test chamber, conditioning cabinet, and automatic temperature controls (from −90° to +600°F) . . . for evaluating stress, elongation, and tear resistance of rubber and other elastomers, up to 500 lbs., in accordance with ASTM and ISO Specifications. Because the total test area is enclosed, Scott Model L-8 makes use of full clamp separation for greater convenience and usefulness.

Essentially three units in one, the new Model L-8 features (1) a compact conditioning cabinet using dry ice with a suitable solvent for low temperature testing, and all-electric heat controls for high temperature testing, (2) a fully enclosed, insulated test chamber with access ports for positioning of specimens, and (3) Scott's modern ACCR-O-METER electronic weighing system with console control panel, load cell, and strip chart recorder which "picturizes" test results in easy to read form. Pipping controls, stretch follower, and other test accessories are also included, as required.

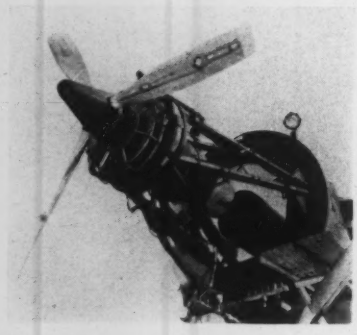
Write today for complete facts on the Scott Model L-8 High-Low Temperature Environmental Tester — for tensiles to 500# (also available Model J-58 for tensiles to 2000# over same temp. range). Scott Testers, Inc., 67 Blackstone St., Providence, R. I. Tel. DExter 1-5650 (Area Code 401).

SCOTT TESTERS

THE SURE TEST . . . SCOTT!

For more information, circle No. 439

MATERIALS ENGINEERING & DESIGN



***'Spinner' cone** for Grumman Mohawk is made of epoxy-fiberglass.*

construction.

Called a spinner, the part contours the nose of the Grumman Mohawk for minimum air resistance (see photo) and is said to offer many advantages over the conventional aluminum counterparts. The epoxy-fiberglass is fabricated in several layers by wet lay-up. This produces the part essentially as one lightweight piece, instead of several heavier aluminum parts joined by several hundred rivets.

Cost is also saved by molding a deicing heater into the new spinner, eliminating the meticulous labor involved in installing separate heaters in previous models.

In selecting materials, it was necessary to take into account not only vibration forces, but also the intermittent heat from the molded-in heating element and the 600-v dielectric strength required to insulate the heater. The resin system selected by Hamilton Standard Div. of United Aircraft Corp., manufacturer of the part, consists of Bakelite epoxy resin ERL-2256 and Sonite No. 41 hardener.

REFRACTORY DATA CORRECTION

Mach 2 performance tests of several refractory materials were reported on p 109 of our September issue. The test temperature, mistakenly shown as 380 F through a typographical error, was actually 3800 F.

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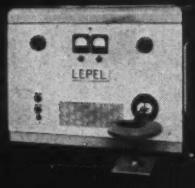

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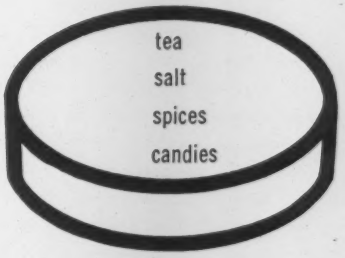

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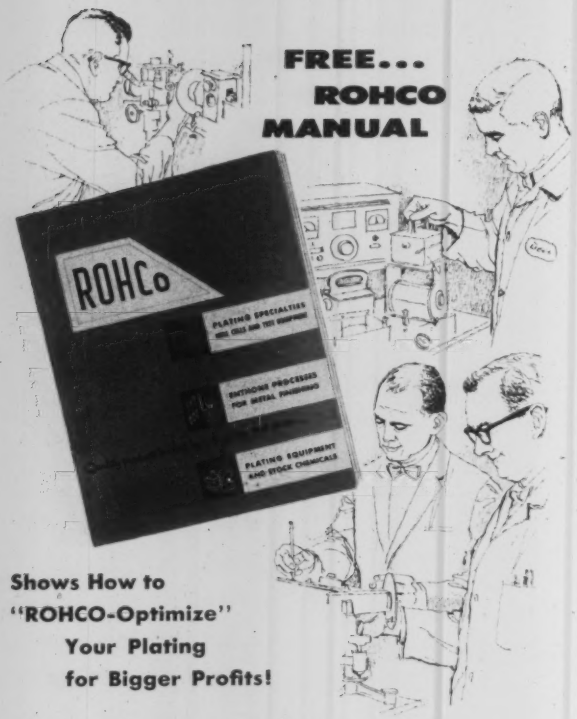

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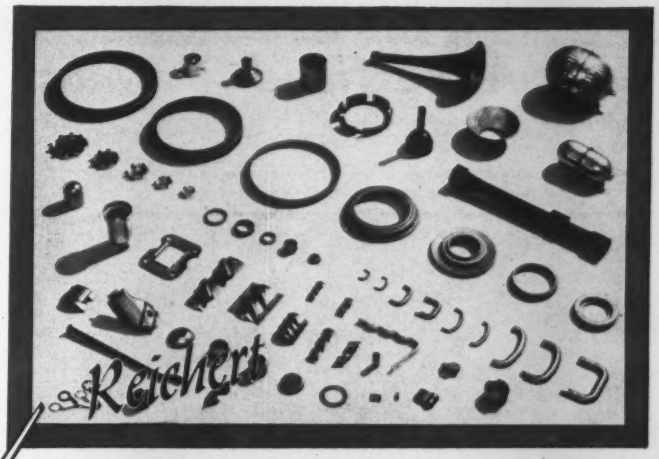

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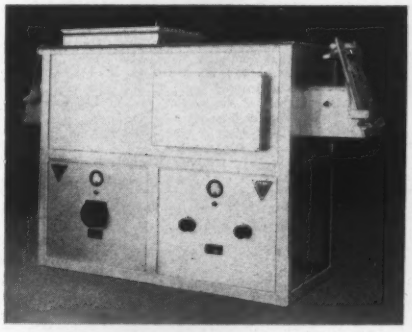

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The last word

editor

by H. R. Clauser

Change and Resistance in the Materials Field

Resistance to change and resistance to new ideas is a natural and common trait of mankind. Even among engineers and scientists, who are supposed to be open-minded and objective, there is often a deep-seated reluctance to discard old, comfortable ideas for new ones. Thus, the famous physicist, Max Planck, encountered such stiff resistance to his formulation of the second law of thermodynamics that he was prompted to bitterly remark: "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."

While Planck's bitterness probably led him to exaggerate somewhat, his statement can be applied to most technical fields, at least to some degree. In the materials field, for example, the new concepts and approaches introduced in recent years have had to face this natural inclination to resist change. Many engineers and designers, traditionally tied to only a few familiar materials, have found it difficut to consider a multiplicity of new materials, or to accept the imaginative work being done in devising composite materials, or to focus their efforts on finding materials with the right combination of properties rather than fitting their designs to a specific material. Likewise, the trend to developing and using specifications based on service requirements and performance rather than on composition or material type has still to be widely accepted.

Nevertheless, in the overall view, the resistance to change in the materials application field is rapidly waning. Ten years ago M/DE was almost alone in supporting such new ideas and concepts as the unified materials approach and the materials engineering function. Today, technical societies, education, industry and a rapidly increasing number of engineers are recognizing these and other new ideas.

This wide acceptance is, indeed, encouraging. And it indicates that we will not have to wait, as Max Planck did, for a new generation to grow up to adopt the modern approaches to materials application.

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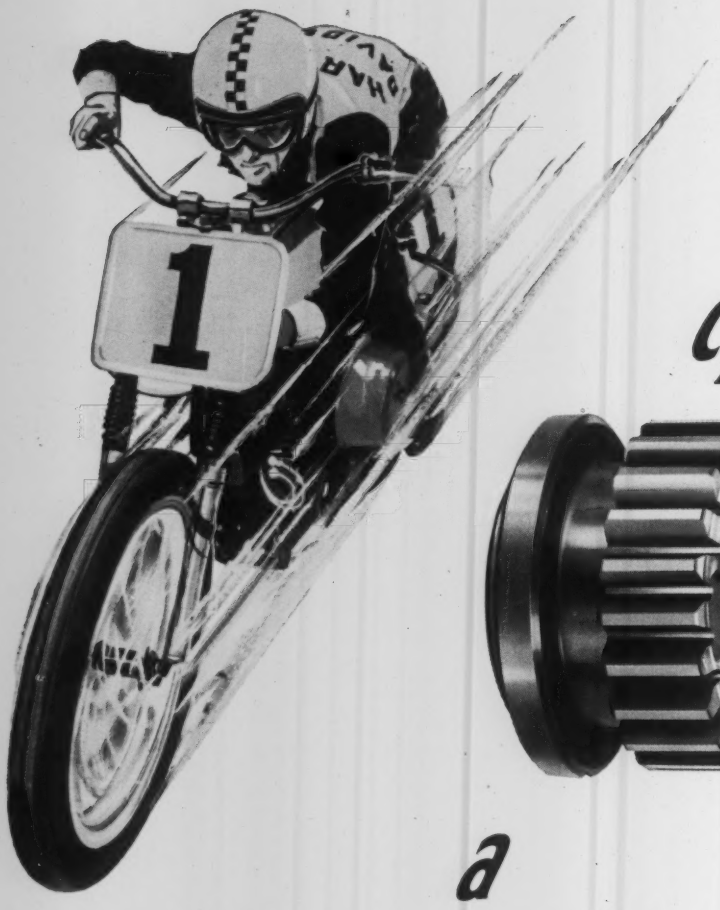

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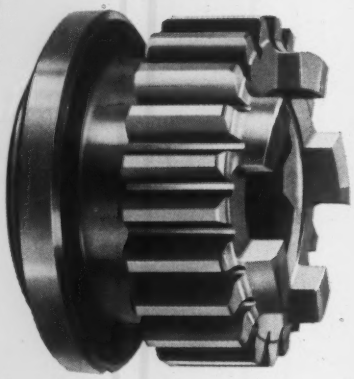

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